2005 Florida Governor's Hurricane Conference

Tornadoes and Tropical Cyclones

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10 DEADLIEST FLORIDA TORNADO OUTBREAKS

FEBRUARY 1998	42 DEAD	
MARCH 1962	17 DEAD	
APRIL 1966	11 DEAD	
JUNE 1972	7 DEAD	HURRICANE AGNES
JANUARY 1936	7 DEAD	
SEPTEMBER 1882	6 DEAD	HURRICANE
SEPTEMBER 2004	6 DEAD	HURRICANE IVAN
APRIL 1925	5 DEAD	
MARCH 1939	4 DEAD	
OCTOBER 1992	4 DEAD	Un-Named Hybrid
APRIL 1988	4 DEAD	

Through 2004

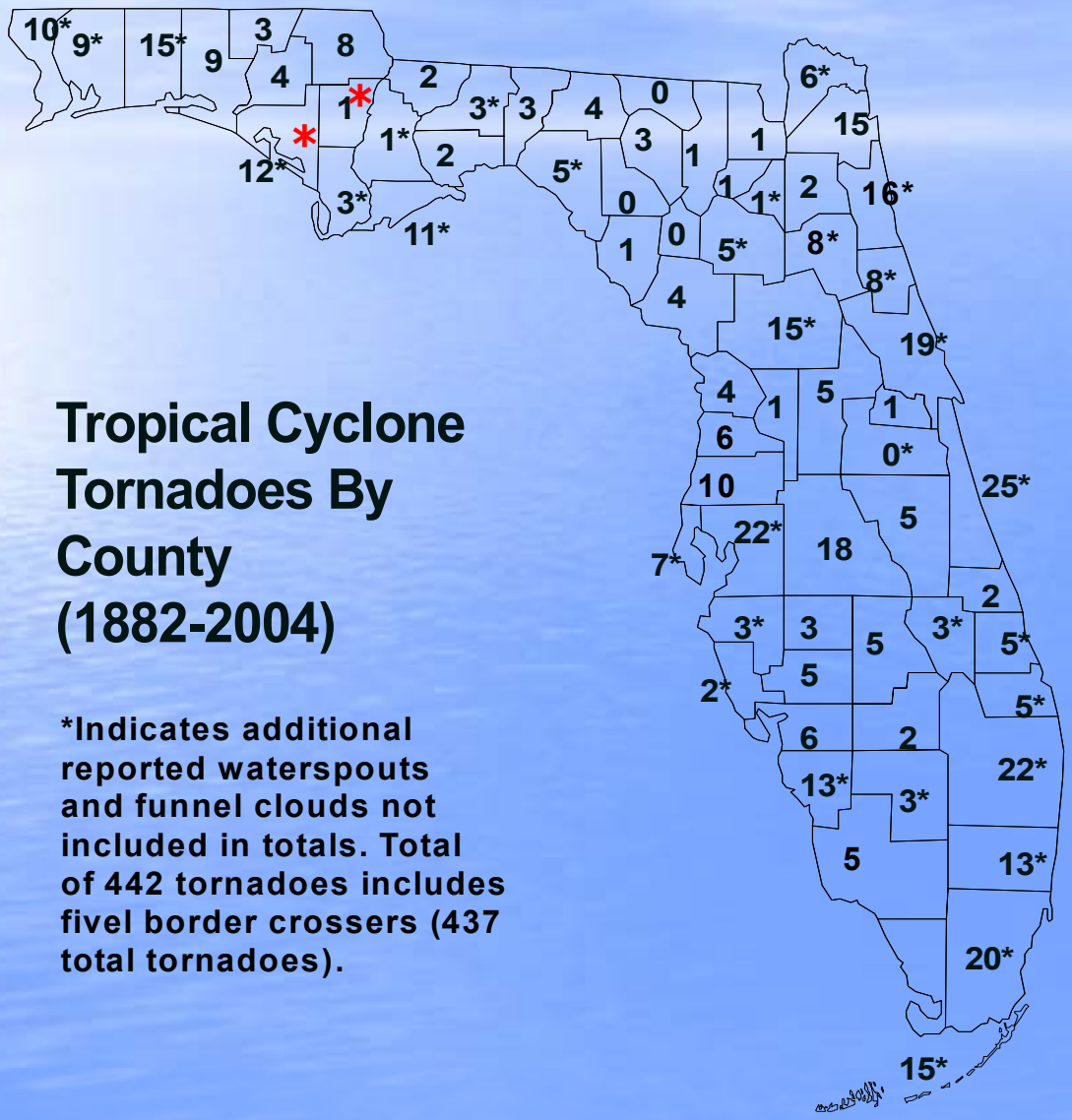
85 Cases in Recorded History (1882-2004)

Florida Tornadoes Associated With Tropical and Sub-Tropical Cyclones 1882-2004

#	DATE	SYSTEM TYPE	#TOR	F#	TIME (EST)	DEATH / INJURY	LOCATION/STM CTR RELATIVE
1	9/9/1882	HURRICANE	5+	2	EVE-AM 10TH	6/17	N CENTRAL/RF
2	10/11/85	T. STORM	1	2	2355	0/8	ALACHUA/RR
3	9/10/1919	HURRICANE	1	2	0112	0/6	DADE/RF
4	9/28/29	HURRICANE	4	2	AFT-EVE	0/16+	SOUTH/RF
5	10/4/33	HURRICANE	3	2	EVE-AM 5TH	0/3	SOUTHEAST/LF
6	9/20/37	T. STORM	1	2	2100	0/0	ST.JOHNS/ RF
7	10/20/41	T. STORM	2	2	AFTERNOON	1/1	N CENTRAL/ RF
8	10/18/44	HURRICANE	3	1	AFTERNOON	0/0	W CENTRAL/ RF
9	6/24/45	HURRICANE	1	1	AM	0/0	BREVARD/ RF
75	9/22/00	TS HELENE	7	1	AM-EVE 22	0/0	NW - BIG BEND/RF
76	10/3/00	DISTURBANCE	4	1	AFT-EVE 3RD	0/0	DADE COUNTY/RF
77	8/2-5/01	TS BARRY	3	1	AM 2/ EVE 5	0/0	EC-SE AND NW/RF
78	9/13-14/01	TS GABRIELLE	*20+	1	AFT13 -14	0/0	SW-CNTRL-NE/RF
79	11/5/01	H. MICHELLE	2	1	AM - AFT	0/0	SE AND S CNTRL/LR
80	9/25/02	TS ISIDORE	* 6	1	AFT-EVE	0/1	PANHANDLE/RF
--	8/14/03	PRE-ERIKA	FC	-	AM	0/0	ST. LUCIE/RF
81	8/12/04	TS BONNIE	6*	2	AFT 12TH	0/0	CENTRAL-NORTH/RF
82	8/13-14/04	H. CHARLEY	16*	2	AM13-AFT14	0/1	CENTRAL/RF
83	9/4-7/04	H. FRANCES	23*	1	AM4TH-PM7TH	0/0	CNTRL-NE/CTR&RF
84	9/15-16	H. IVAN	20*	2	AFT15-AM16	6/16	NW-PANHANDLE/RF
85	9/25-26	H. JEANNE	9*	1	EVE 25-EVE26	0/0	EC-NE/CENTER&RF

2004 Record Season with 74 Tornadoes

Tornadoes Have Occurred In 63 of 67 Counties



Tropical Cyclone Tornadoes By County (1882-2004)

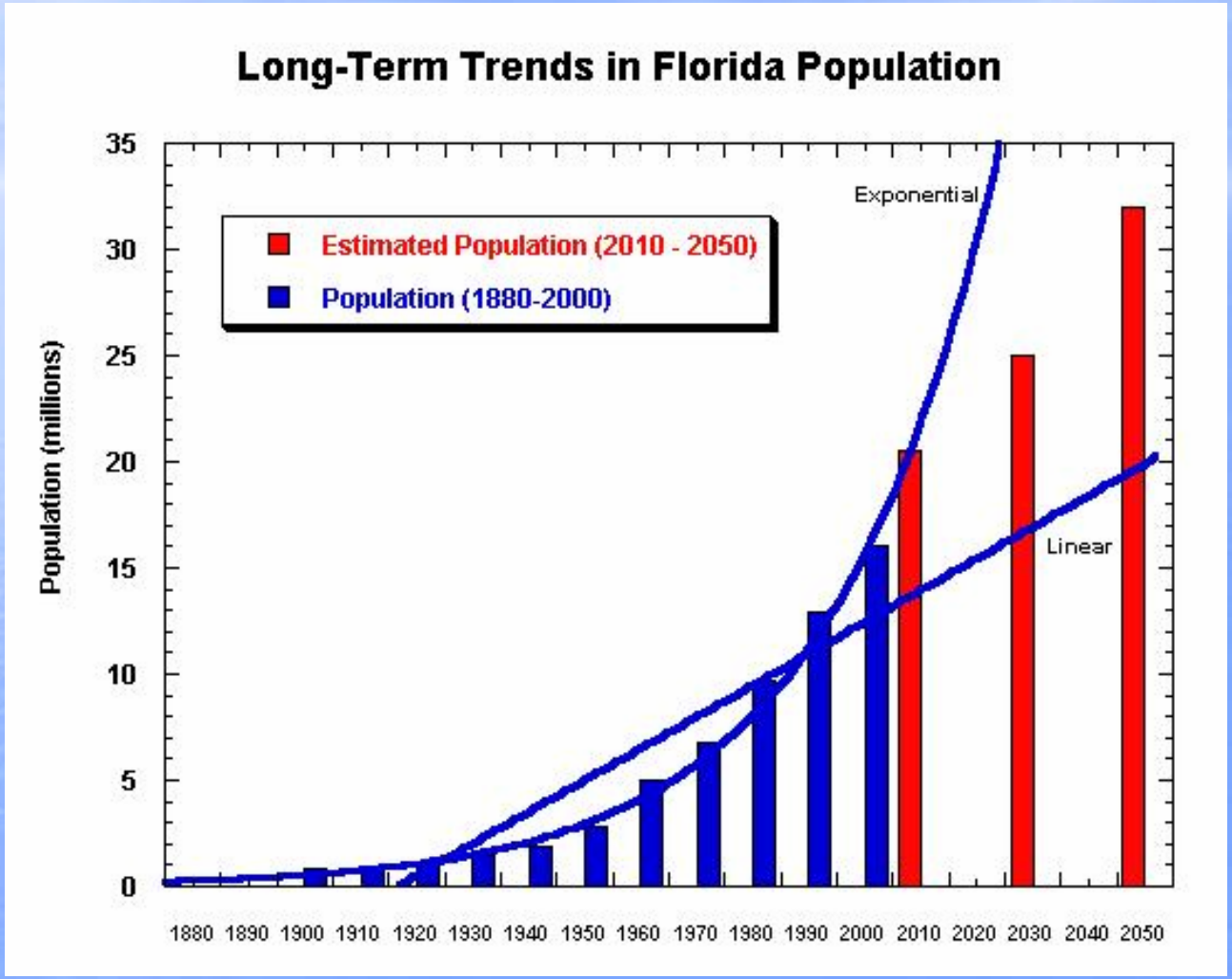
*Indicates additional reported waterspouts and funnel clouds not included in totals. Total of 442 tornadoes includes fivel border crossers (437 total tornadoes).

Top 10 Counties

Brevard (25)
Hillsborough (22)
Palm Beach (22)
Dade (20)
Volusia (19)
Polk (18)
St. Johns (16)
Okaloosa (15)
Marion (15)
Duval (15)
Monroe (15)

*Calhoun (4) and Bay (2) Counties With fatalities in 2004

Increasing Population - Increasing Tropical Cyclone Activity - Greater Documentation - Greater Risk

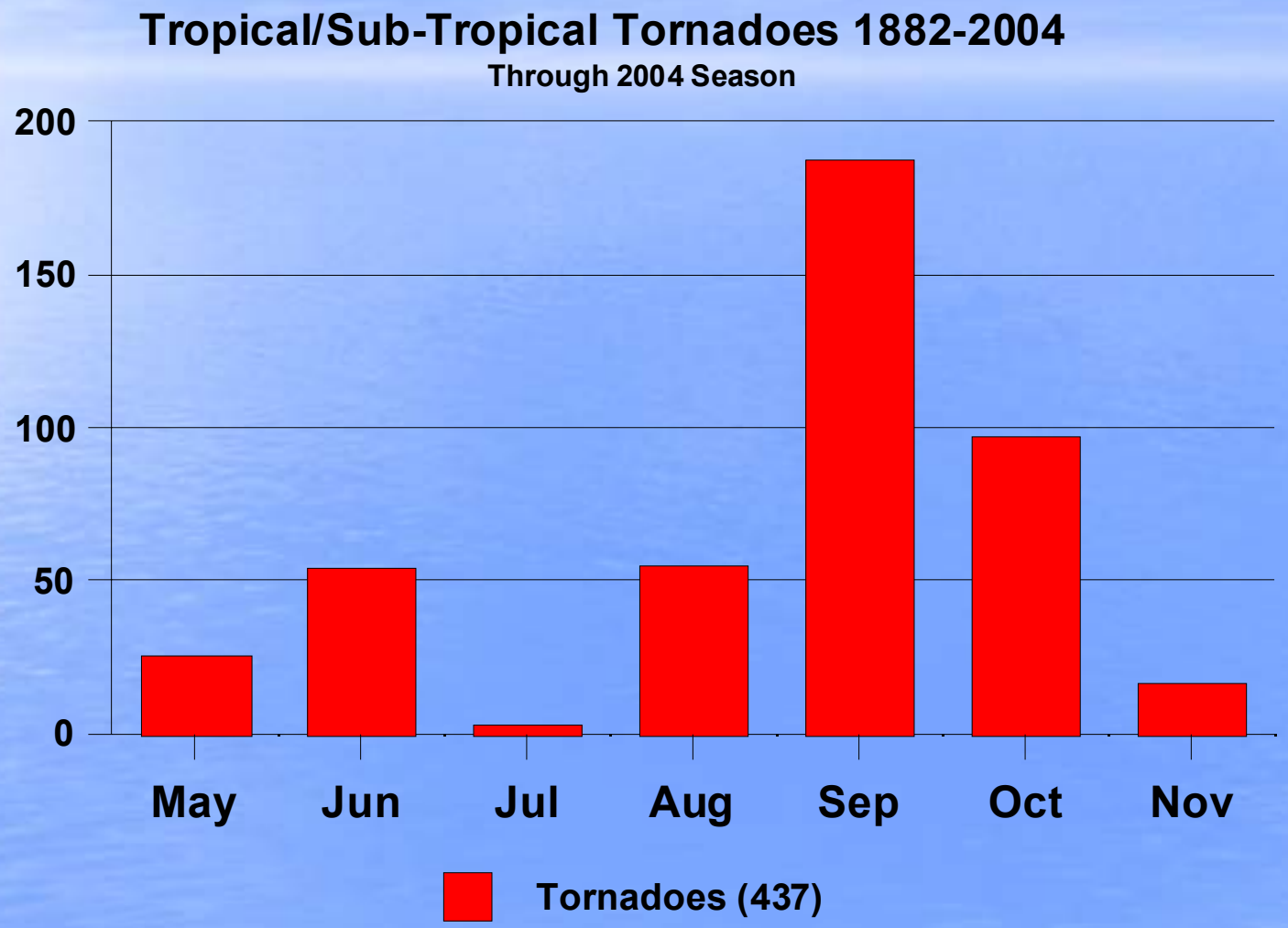


Bonnie – Charley – Frances – Ivan - Jeanne

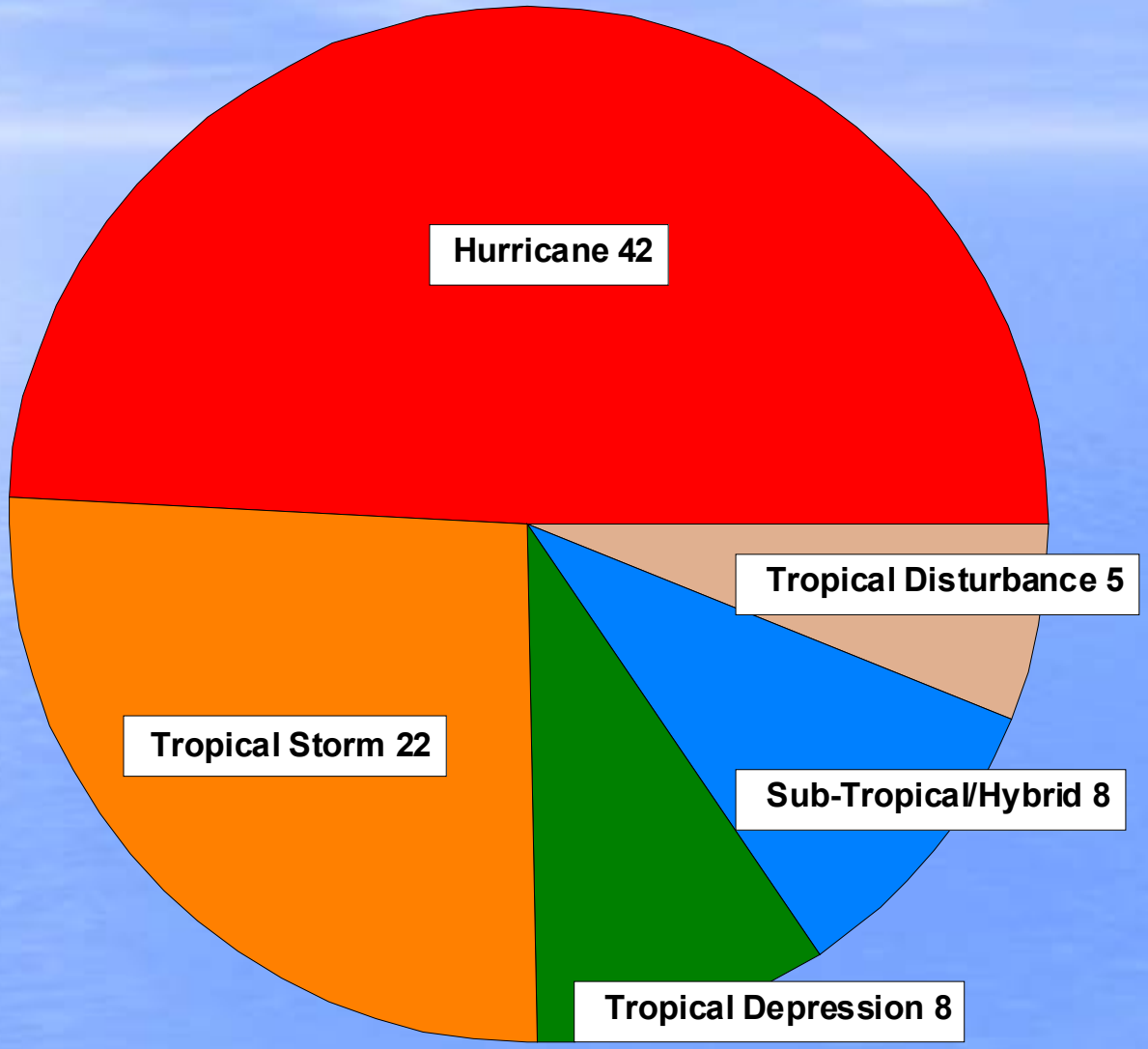
- **Record Season with 74 Tornadoes**

54 F0, 17 F1, 3 F2

Tornadoes By Month



Types of Tornado-Producing Systems (1882-2004)



What are Hybrid or Subtropical Cyclones ?

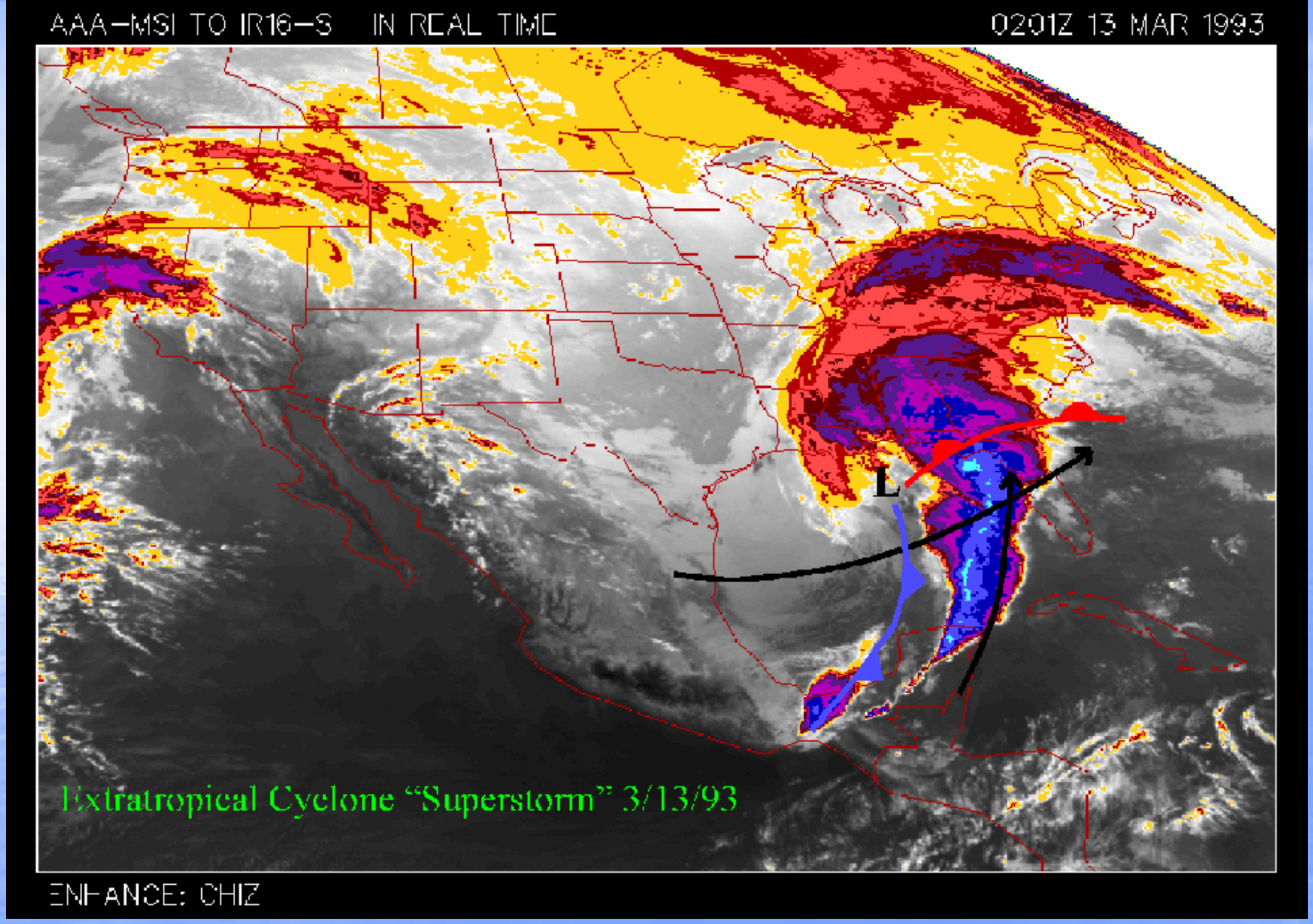
Low pressure systems that exhibit both tropical and extratropical characteristics

Typically tropical-like at the surface with non-tropical influences aloft - often highly sheared.

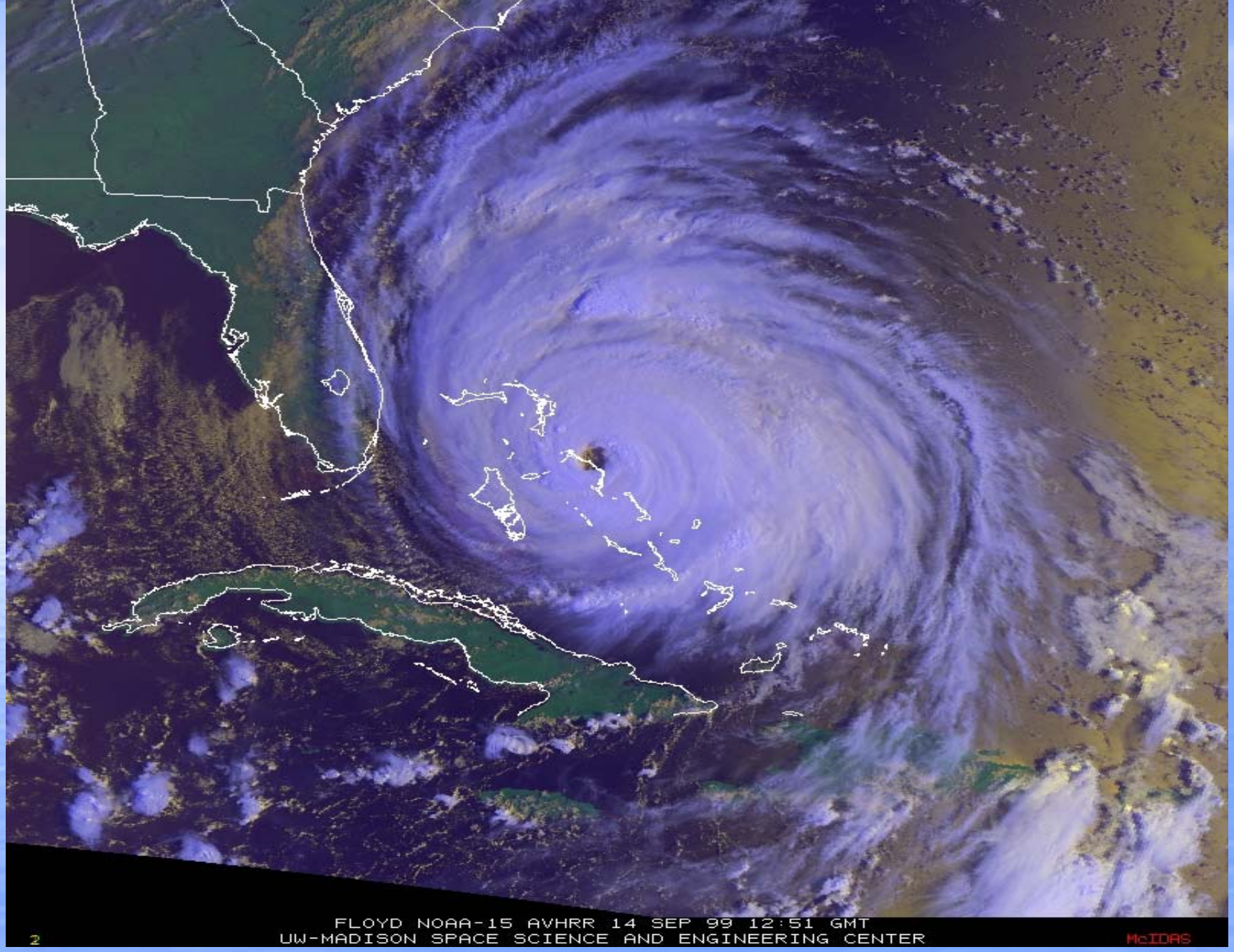
Most likely in May, June, October and November - the transition months between wet and dry seasons.

Hybrid Storms may not meet traditional criteria for naming - such as the October 1992 storm that struck Tampa Bay area.

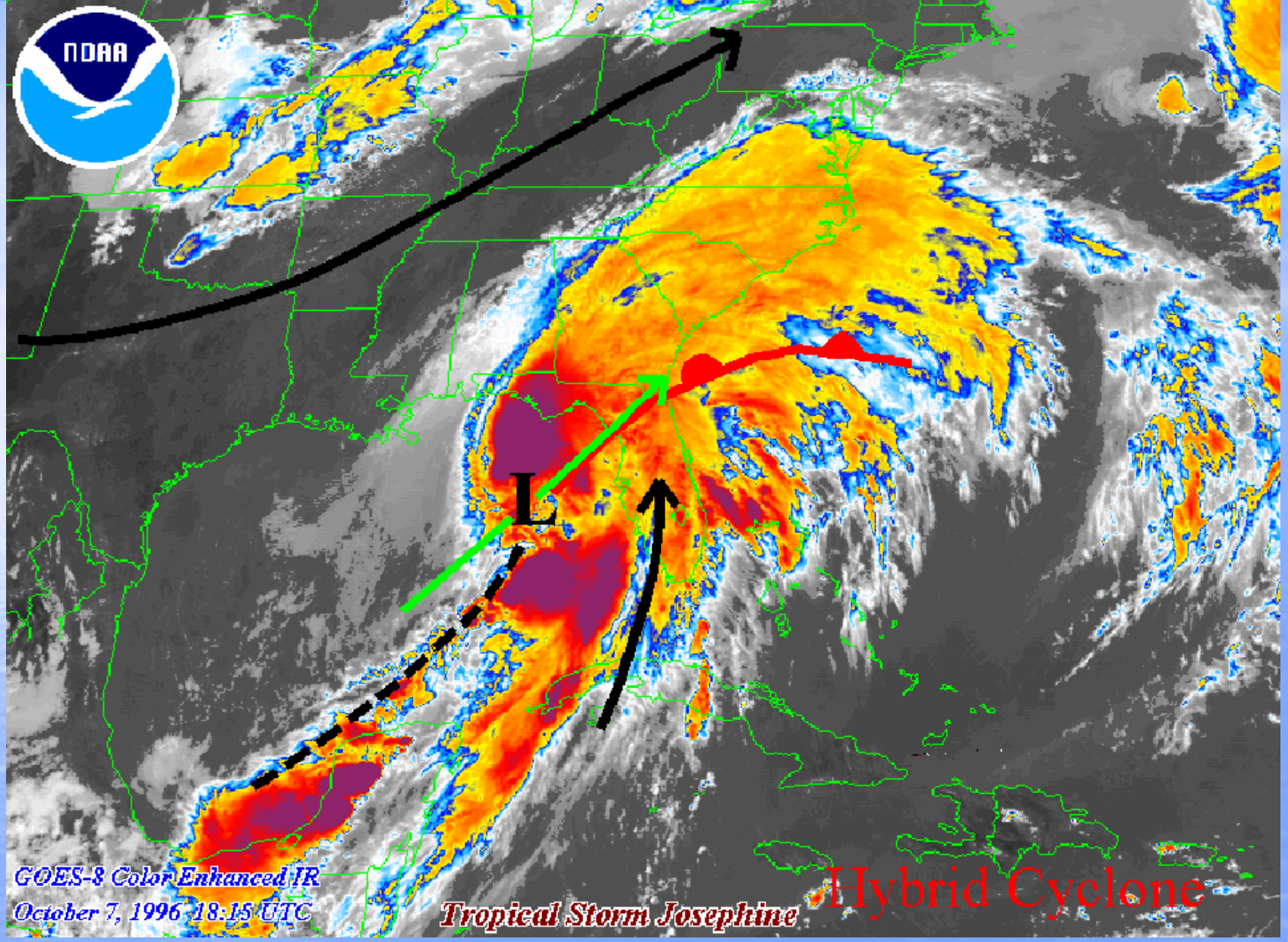
Many “Named” tropical cyclones have considerable hybrid influences - not purely tropical. It is estimated that over half of the tornado cases had some hybrid characteristics.



Extratropical Cyclone

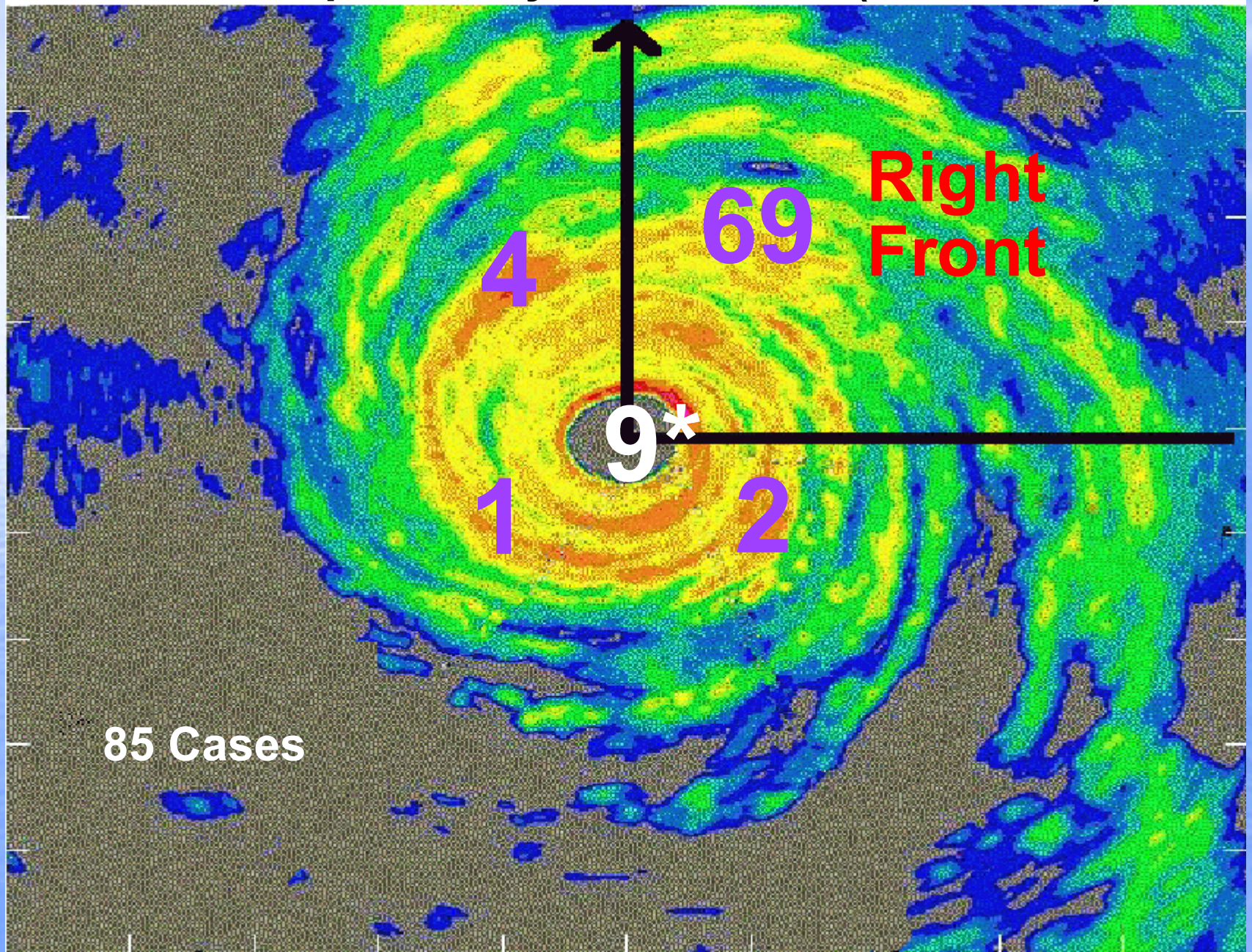


Tropical Cyclone



Subtropical or Hybrid Cyclone

Location of Tornadoes Relative to Cyclone Center With Respect to Cyclone Motion (1882-2004)



Tropical/Hybrid Cyclone Tornado Strength Characteristics

48% of cases produce F2 or greater tornadoes
(a much higher percentage compared to non-tropical/hybrid cyclones)

52% of cases produce weak tornadoes

65% of cases produce 4 or fewer tornadoes

TORNADO STRENGTH MEASURES	HURRICANE STRENGTH COMPARISON
Fujita or F-Scale	Saffir-Simpson Scale
F0 40-72 MPH - slight damage	Tropical Storm
F1 73-112 MPH - moderate damage	CAT 1 (74-95 MPH) through CAT 2 (96-110 MPH)
F2 113-157 MPH - considerable damage	CAT 3 (111-130 MPH) through CAT 4 (131-155 MPH)
F3 158-206 MPH - severe destruction	CAT 5 >155 MPH
F4 207-260 MPH - complete destruction	
F5 261 and greater - complete devastation	

Updated through 2004

Typical F0 Tornado Damage in Florida (New Smyrna Beach). Damage primarily to structures attached to houses such as screen rooms, car ports, awnings, and non-anchored outbuildings and structures.

Representative F1 Tornado Damage in Florida (New Smyrna Beach). Severe roof damage, windows, and doors broken, trees down and cars flipped over, but integrity of structure generally remains.

Representative F2 Tornado Damage in Florida (New Smyrna Beach). Typically roofs are gone or mostly gone with most walls remaining standing.

Representative F3 Tornado Damage in Florida (New Smyrna Beach). Two-story frame house severely damaged with 2nd floor totally gone and first floor a total loss.

Representative F4 Tornado Damage in Florida (Kissimmee). New concrete block/stucco house totally destoyed much of home swept off the foundation. An F5 would leave a bare concrete slab!

(There has never been an F5 Tornado in Florida)

FOCUS ON SIGNIFICANT TROPICAL/HYBRID CYCLONE TORNADO EVENTS!

Any Tornado-Related Death

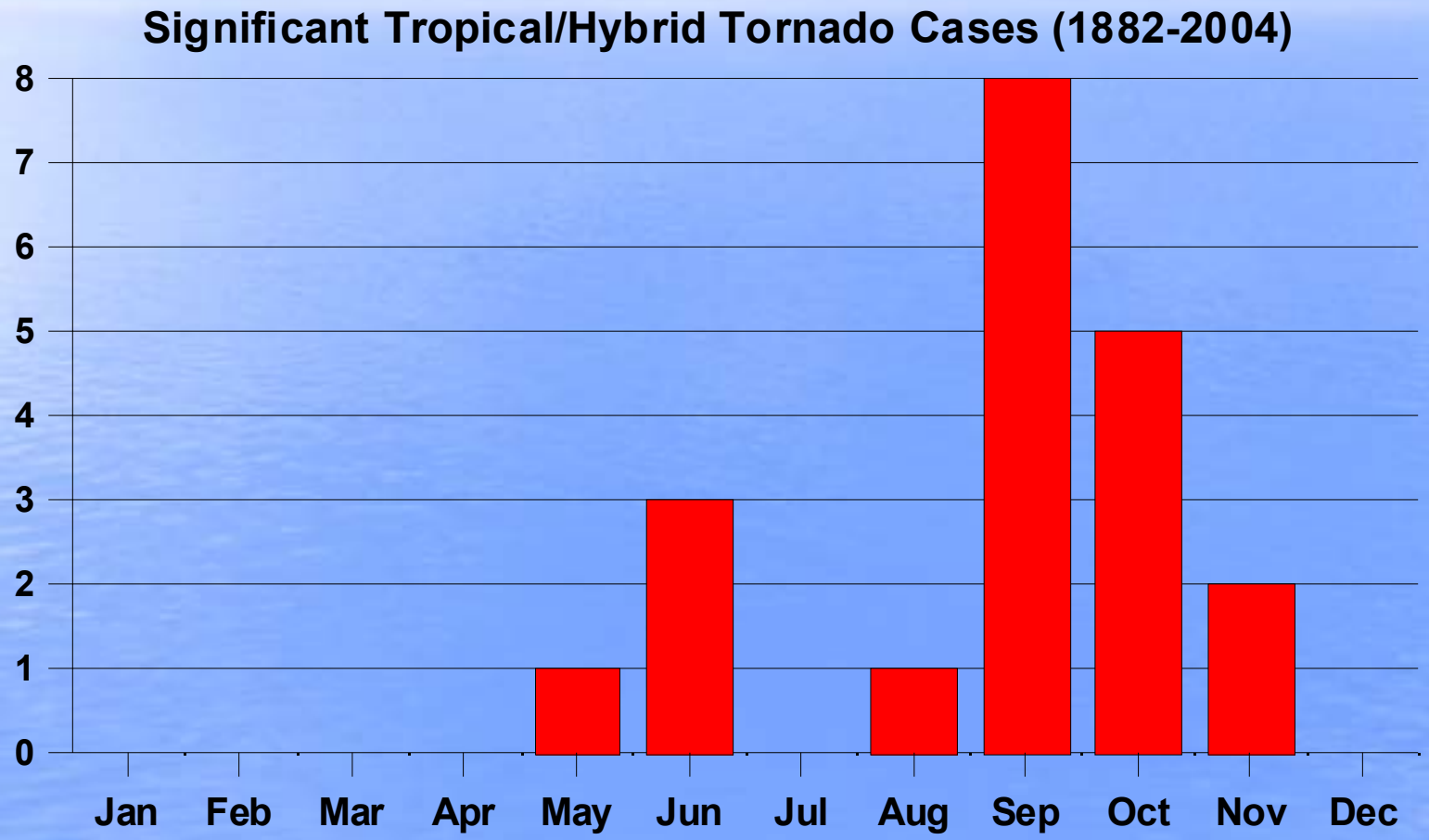
Five or More Tornadoes in 24-Hour Period With at Least One Tornado of F2 or Greater Intensity

Any F3 Tornado

20 Significant Cases in Recorded History:

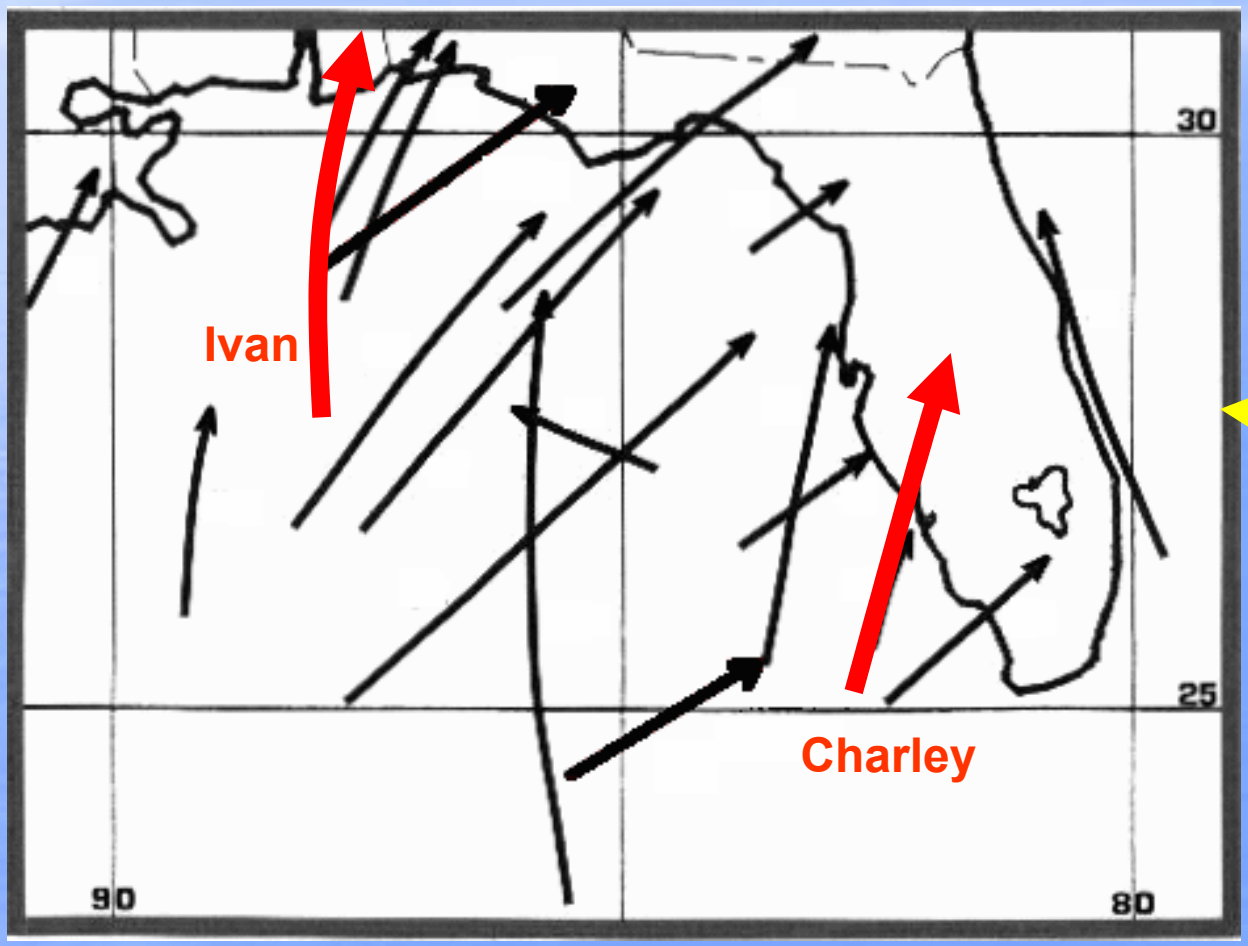
10 Huricanes, 6 Tropical Storms, and 4 Hybrid Cyclones

Significant Cases Consist of Early Season and Peak to Late Season Cyclones



Track Segments of Significant Tropical/Hybrid Cases During Florida Tornado Production Phase 1882-2004

(No Significant Cases in 1999-03 Seasons)



Frances and Jeanne Not Significant Tornado Events

All Significant Tornado Cases Began Well Before Landfall

Historical Observations of the Nature of Significant Tropical and Hybrid Cyclone Tornado Events

20 Cases - Nearly Half have hybrid influences - Cyclone Central Pressure and Organization is a Poor Predictor of Tornado Potential

19 of 20 in Gulf of Mexico at Time of Tornadoes

19 of 20 Produced Tornadoes in Outer Rainbands in the Right-Front Quadrant with Respect to Storm Motion

18 of 20 Moving Between 360 and 60 Degrees

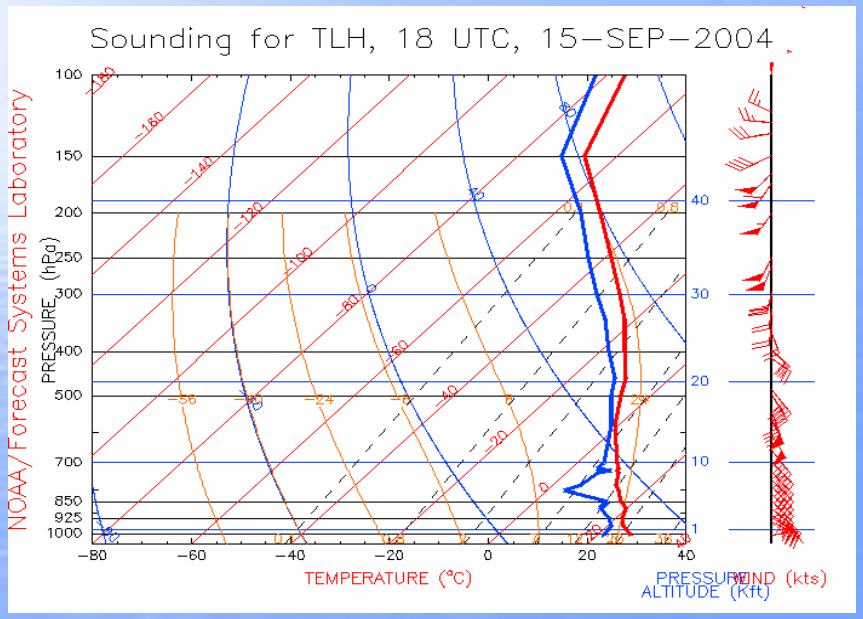
18 of 20 Recurving or Moving Northeast - Upper Low NW of Florida

In All Cases Tornadoes Began Before landfall

10 of 20 Began and Ended Before Landfall - little correlation between center landfall and tornado occurrence

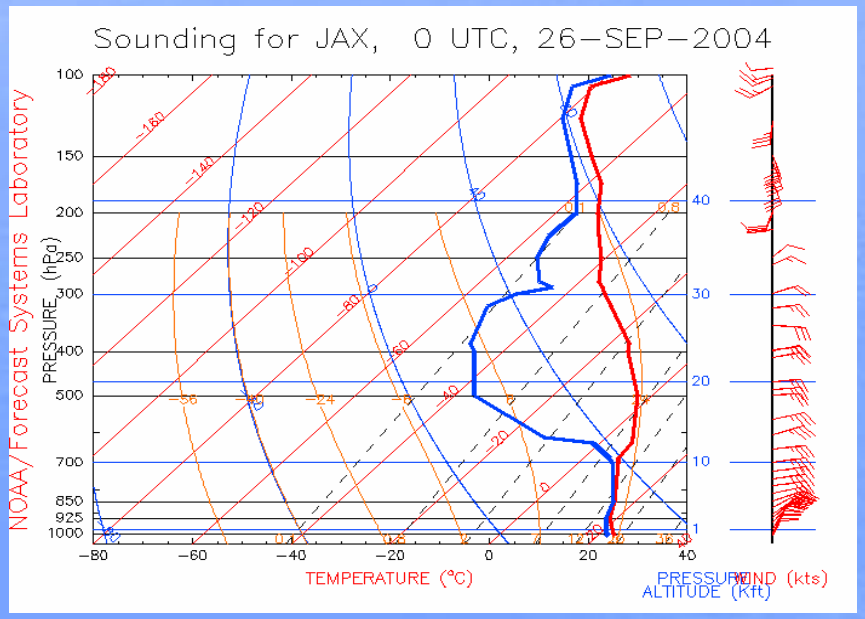
Differences in Gulf and Atlantic Pre-Storm Environment

Strong Shear



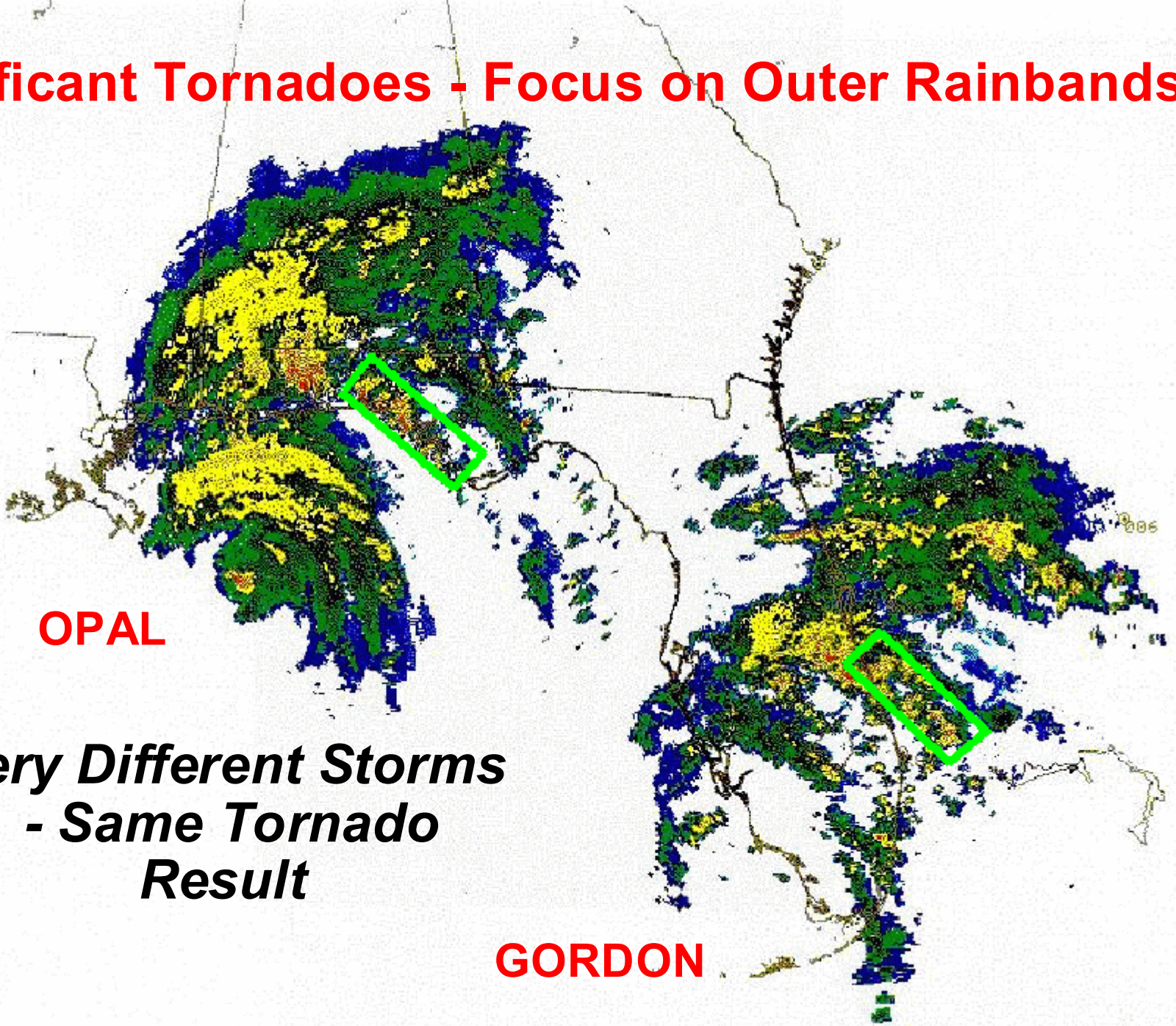
Ivan Pre-Landfall

Weak Shear

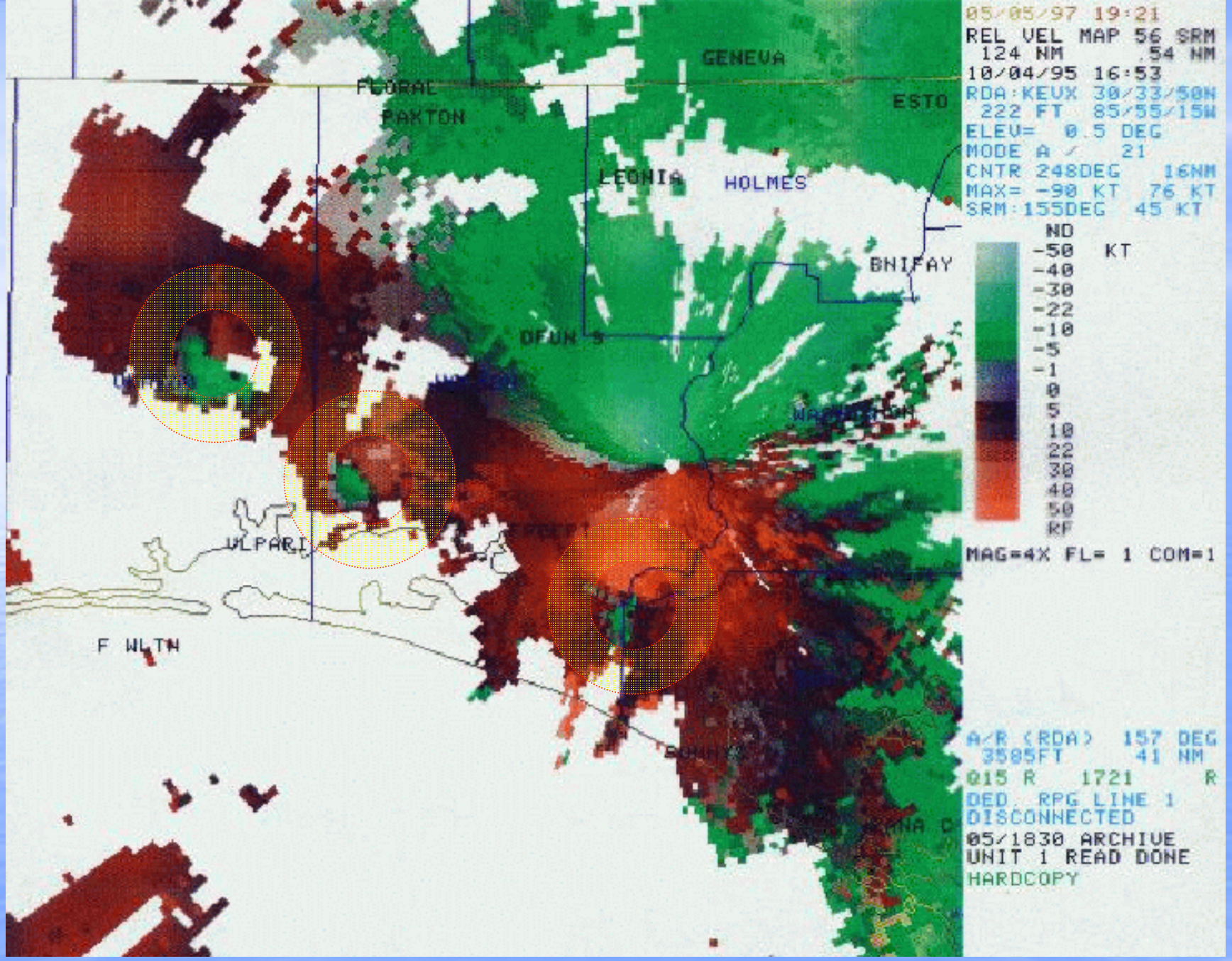


Jeanne Pre-Landfall

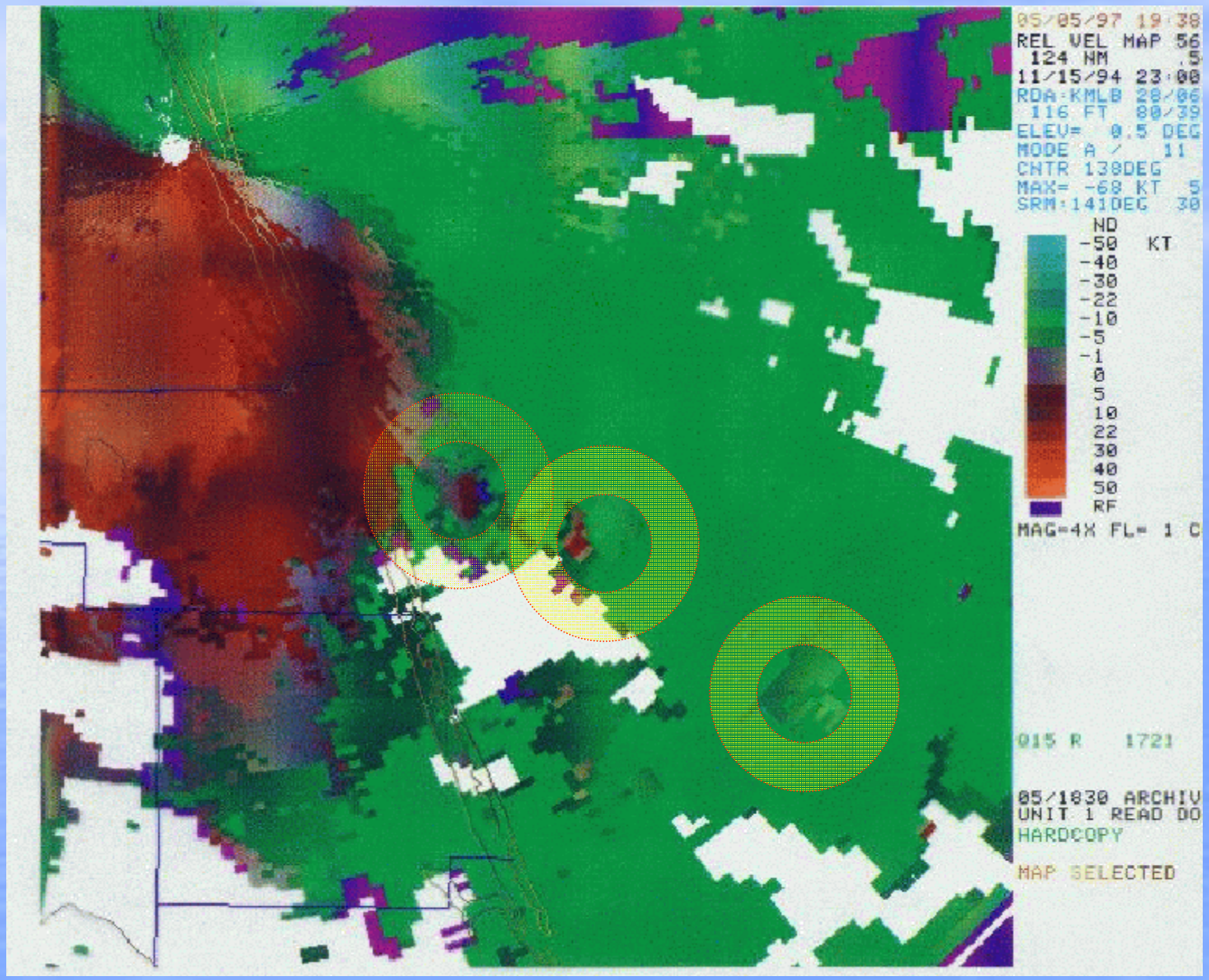
Significant Tornadoes - Focus on Outer Rainbands



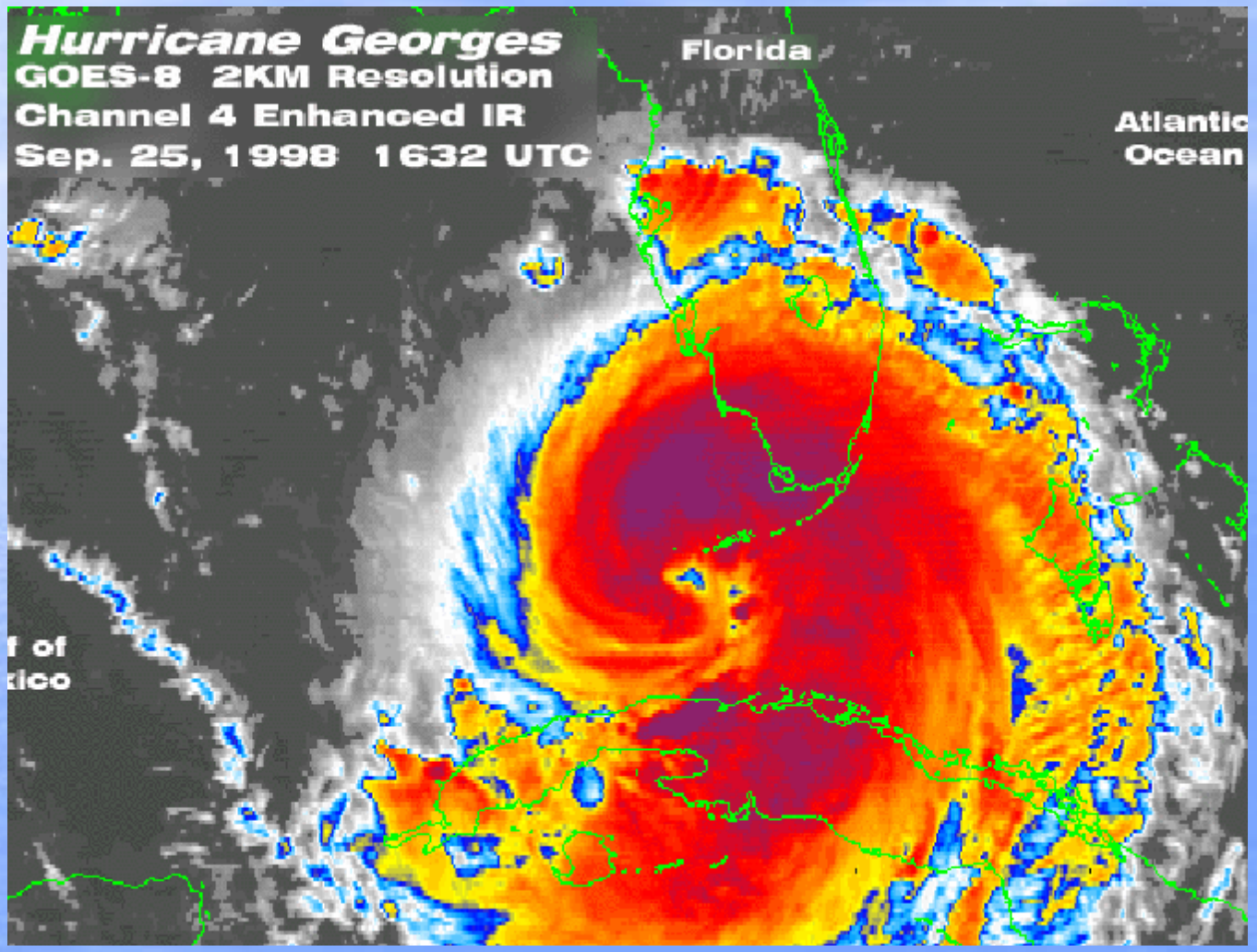
Very Different Storms - Same Tornado Result



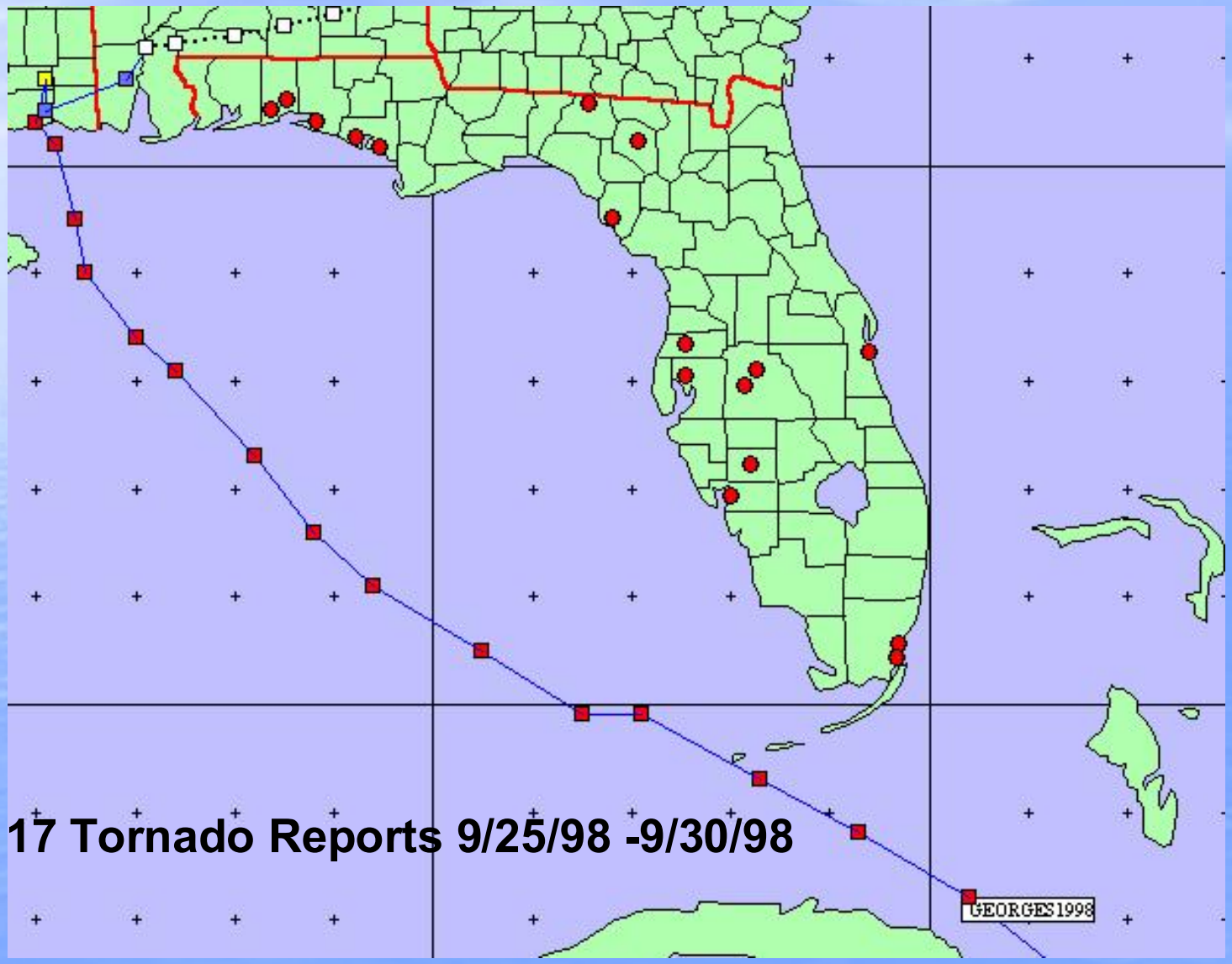
Hurricane Opal 10/4/95 - F2 Tornado 1 Dead



Tropical Storm Gordon 11/15/94 - F2 Tornado 1 Dead

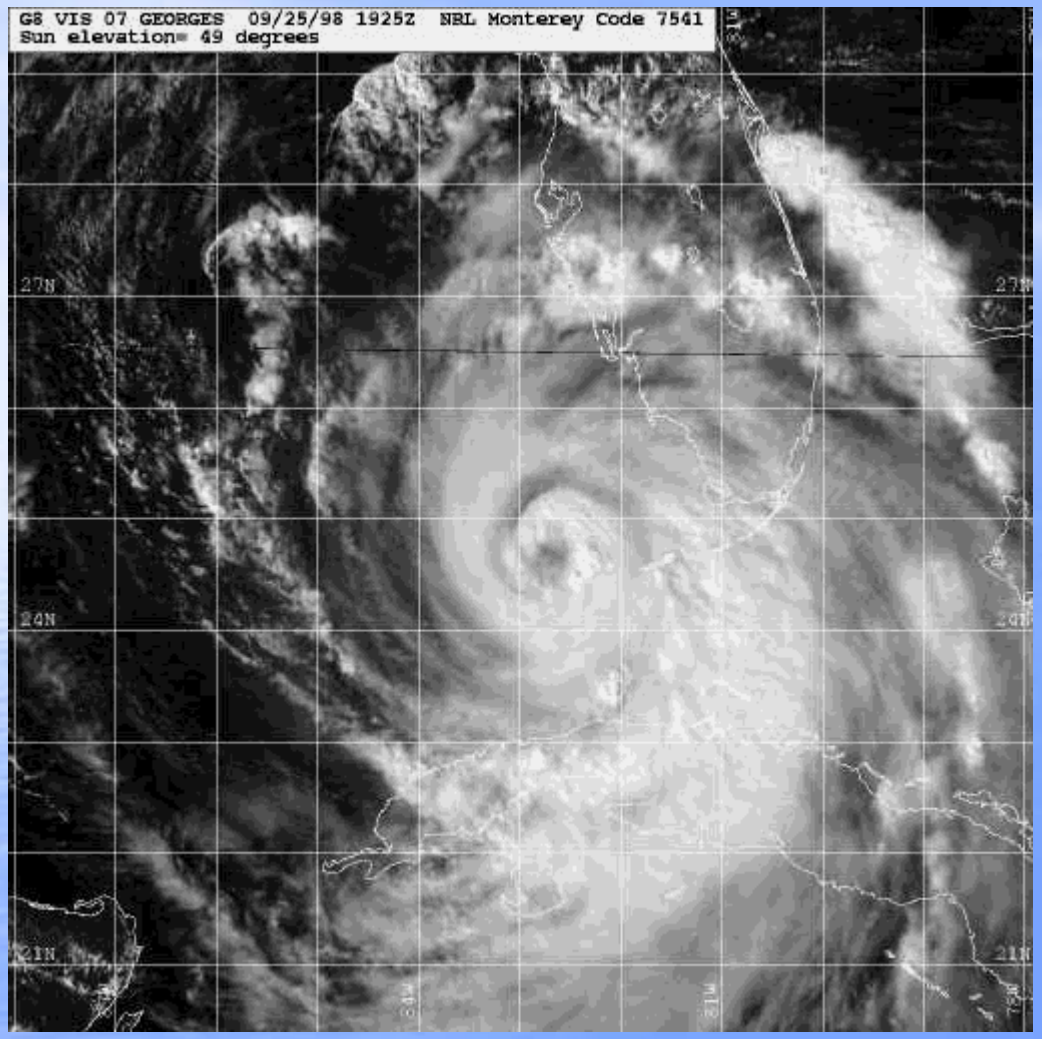

Hurricane Georges
GOES-8 2KM Resolution
Channel 4 Enhanced IR
Sep. 25, 1998 1632 UTC
Florida
Atlantic
Ocean

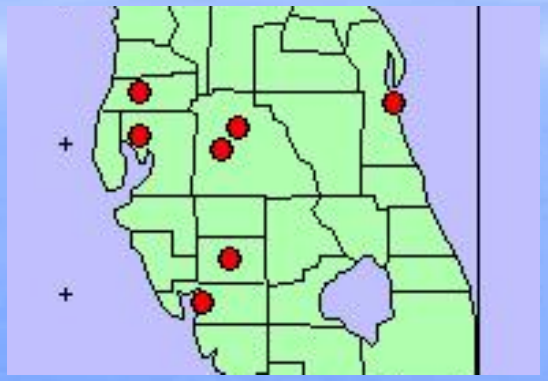
Hurricane Georges - Most Extended Tornado Threat in Florida History



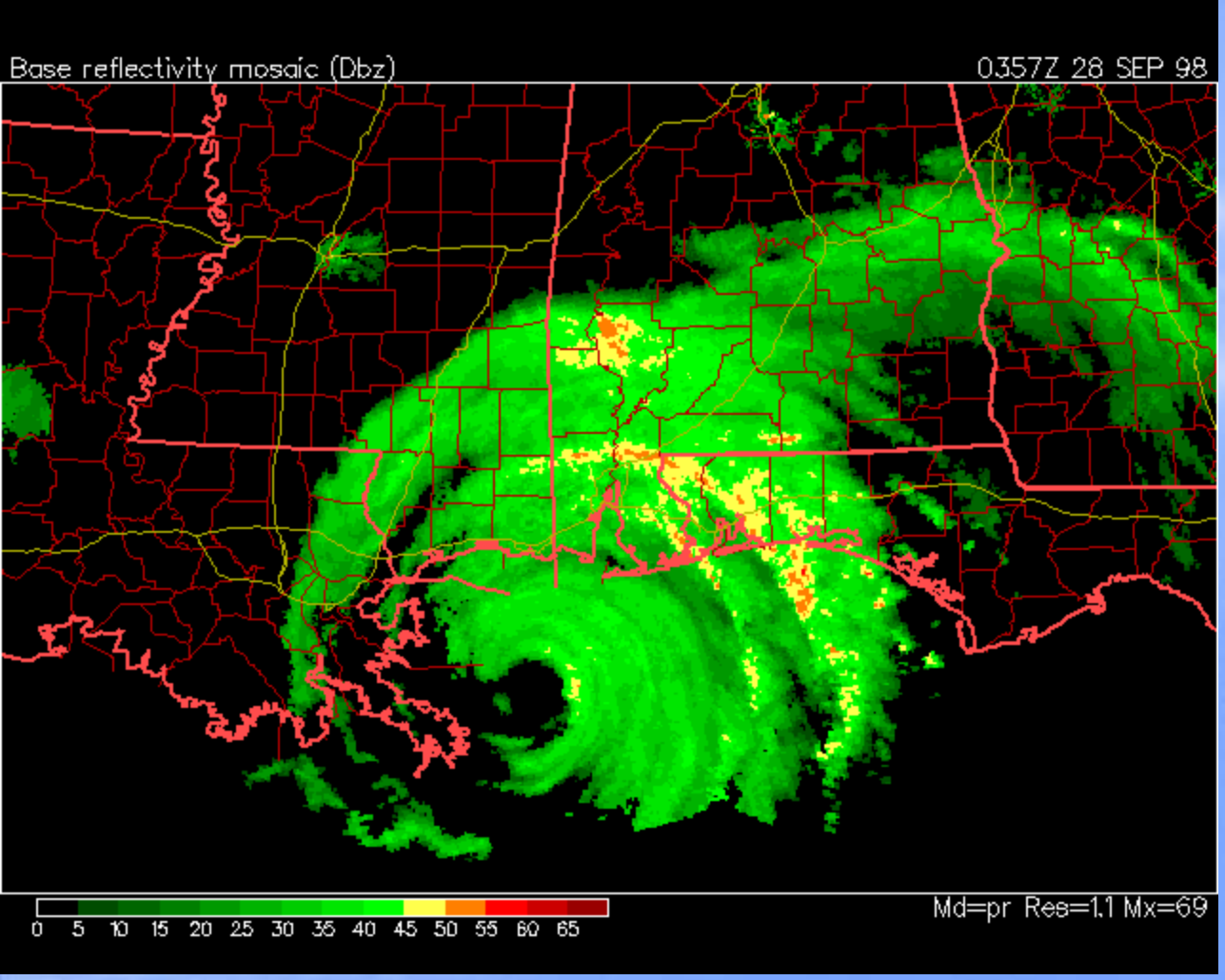
17 Tornado Reports 9/25/98 -9/30/98

F0-F1 Tornado Outbreak 9/25/98

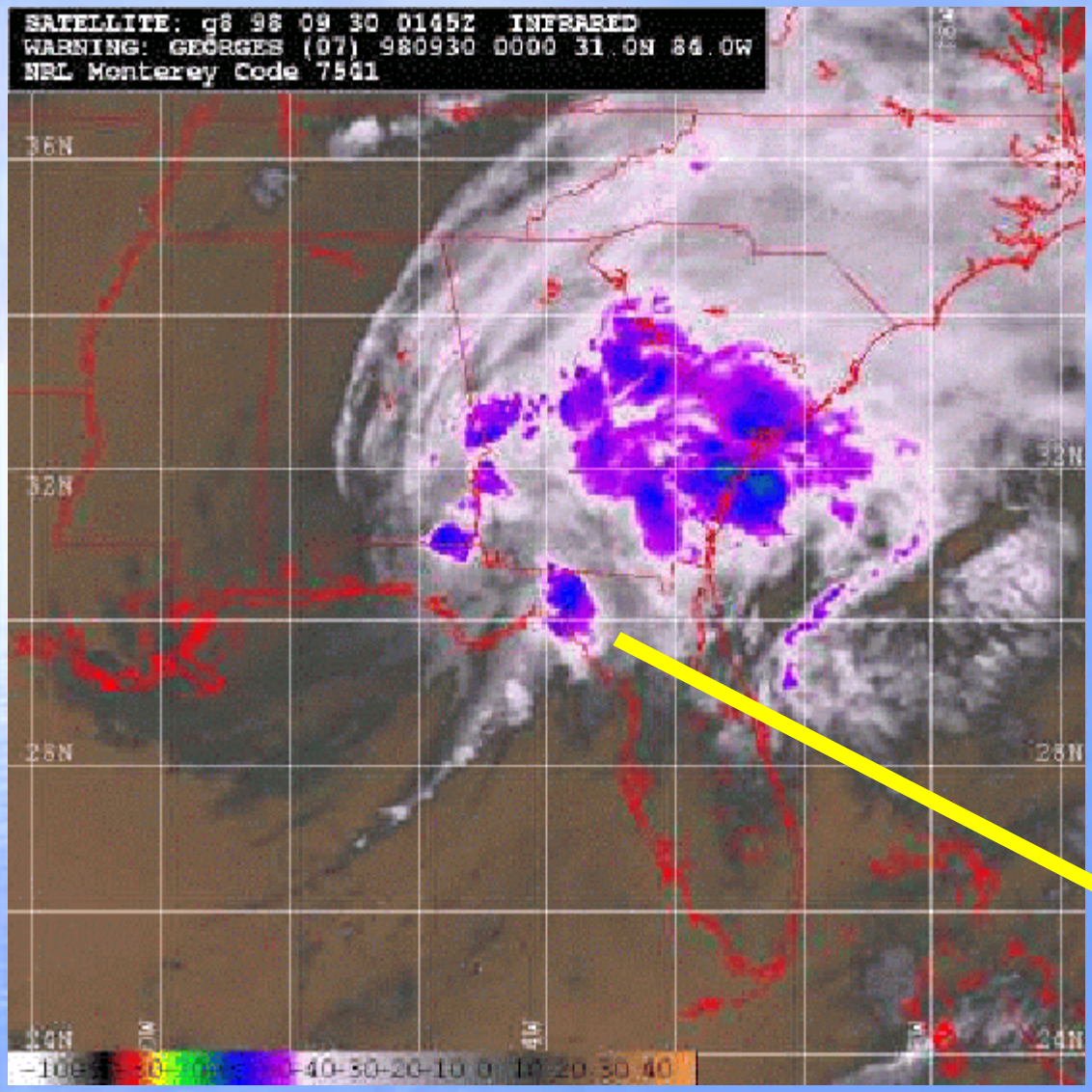




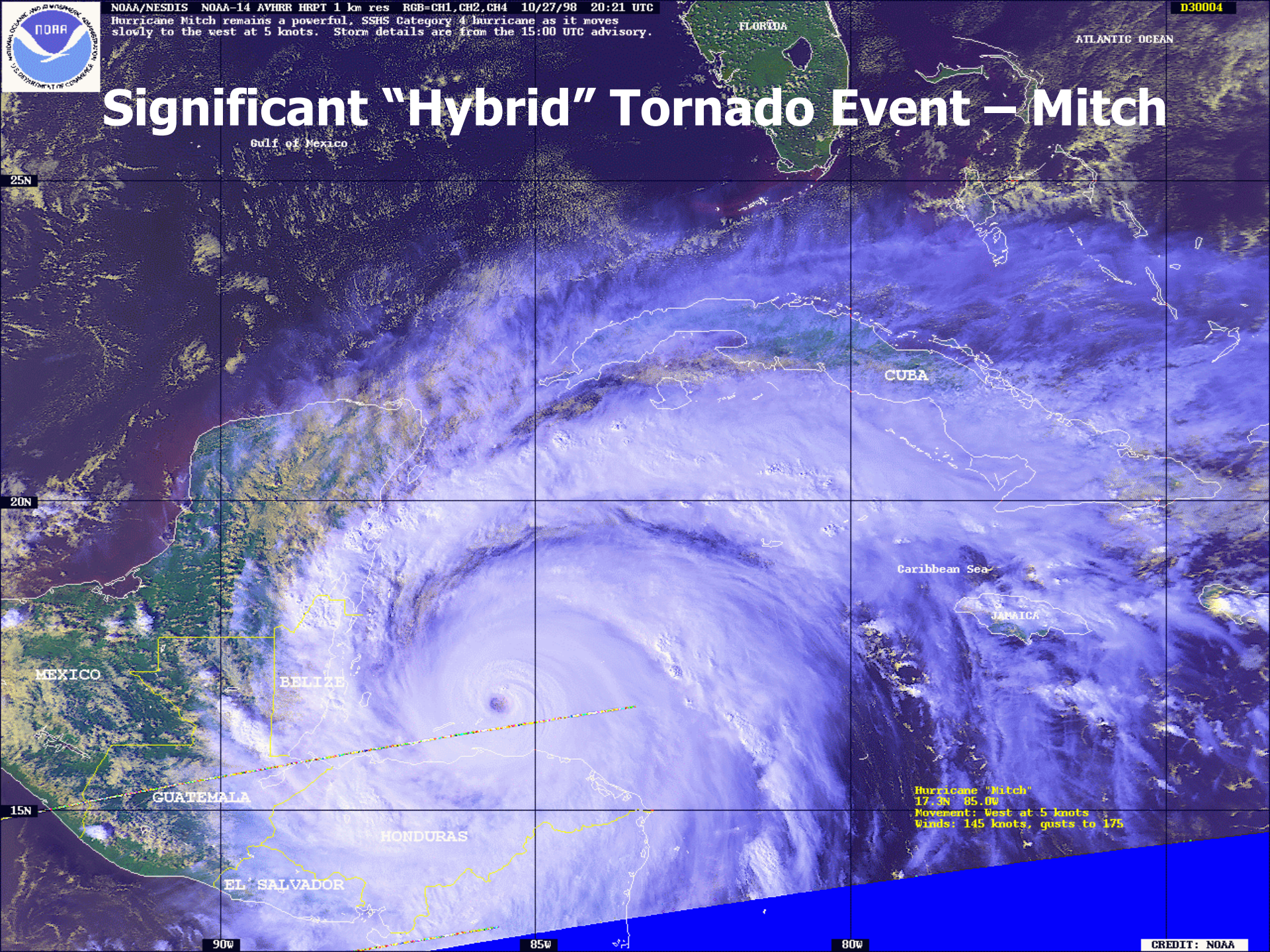
Tornado Watches in effect from 6 am 25th to 6 am 26th - 7 tornadoes occur in a few hours!



Weak Tornadoes reported in the Panhandle on the 27th and 28th as Georges slows and weakens

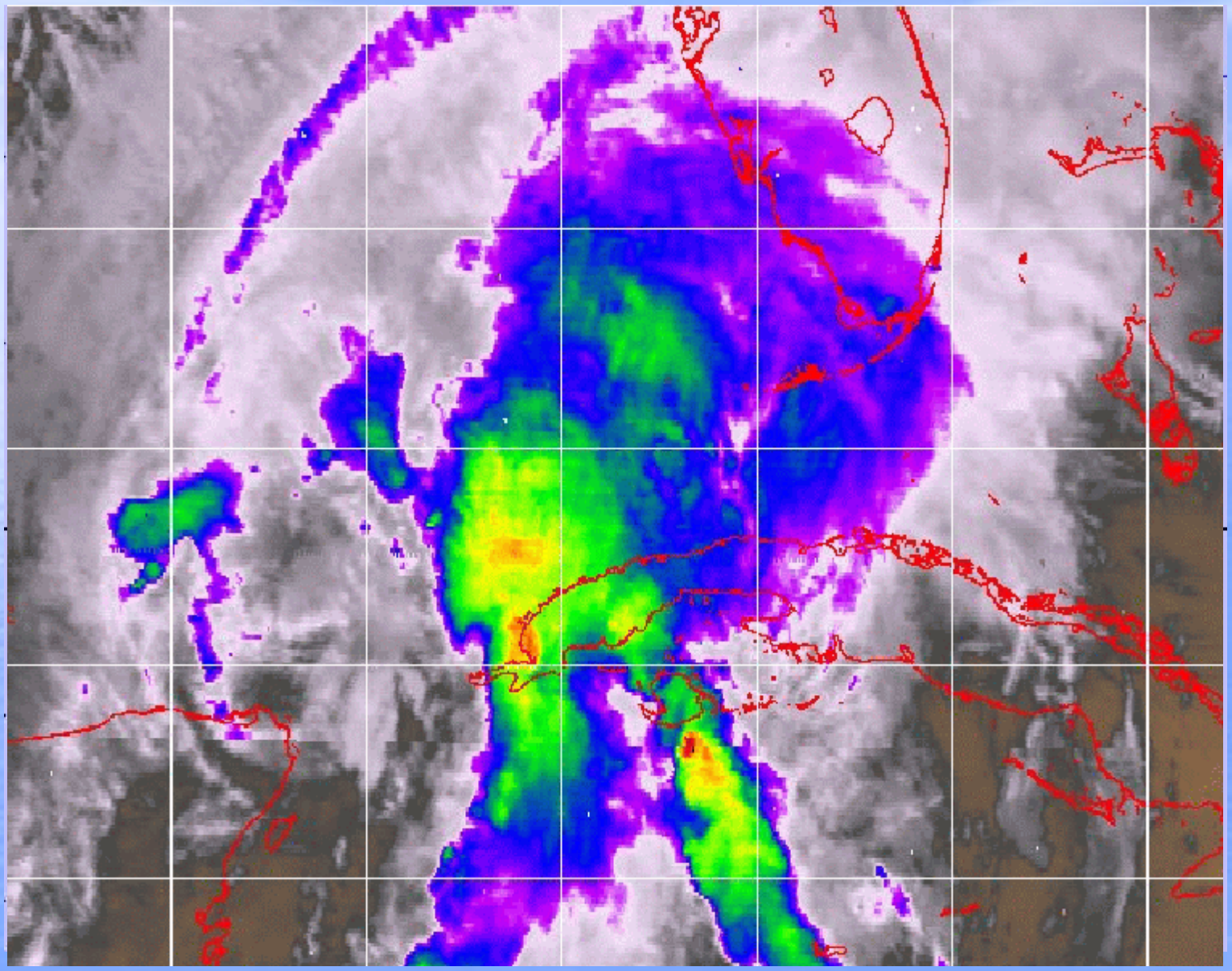


Near Midnight on 9/29/98 - After Dissipation and in the presence of sinificant shear "Georges" Produced the Strongest Tornado

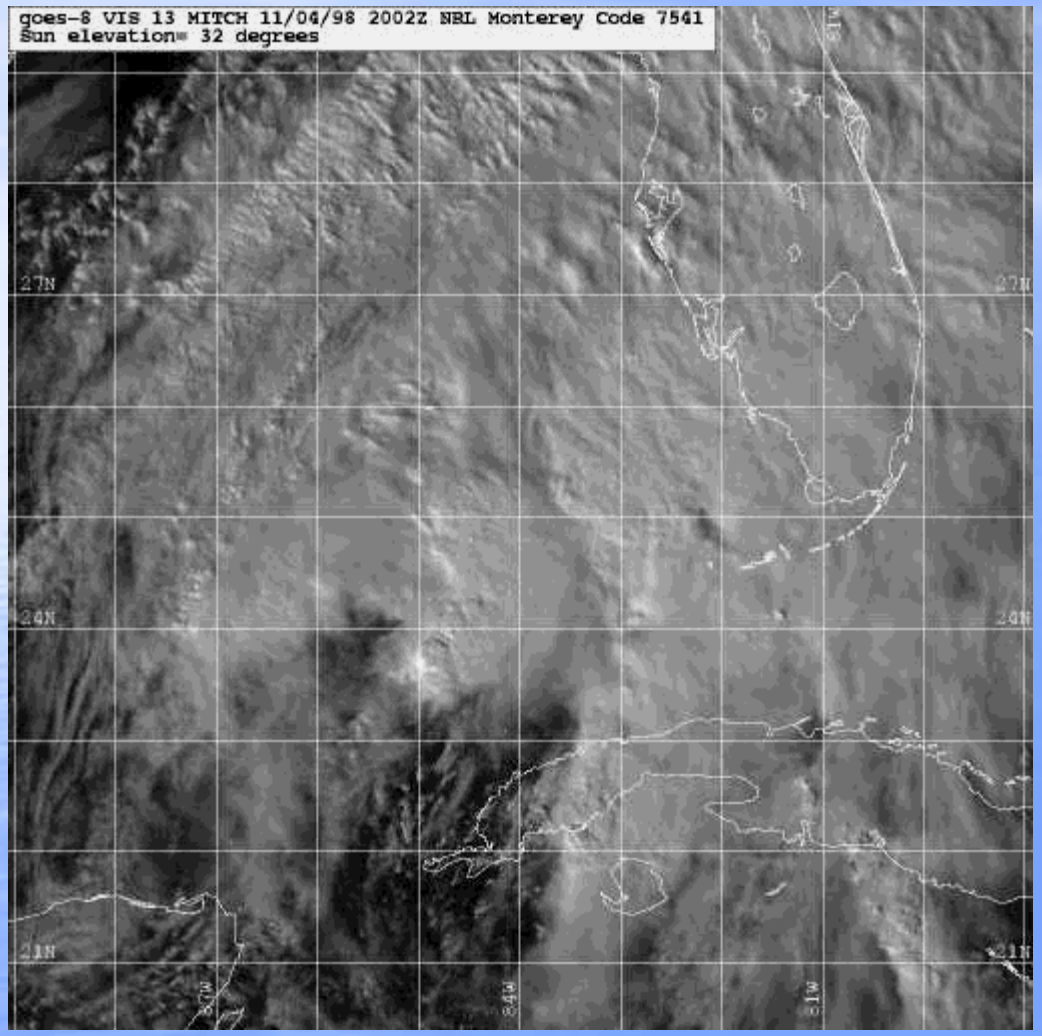


Significant "Hybrid" Tornado Event – Mitch

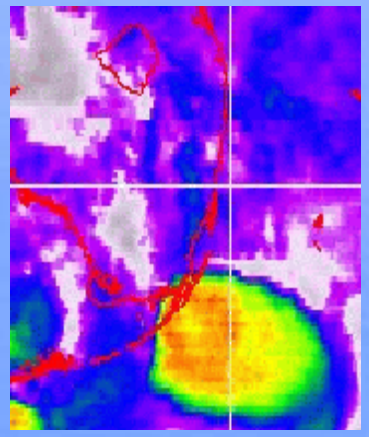
Significant “Hybrid” Tornado Event -Tropical Storm Mitch



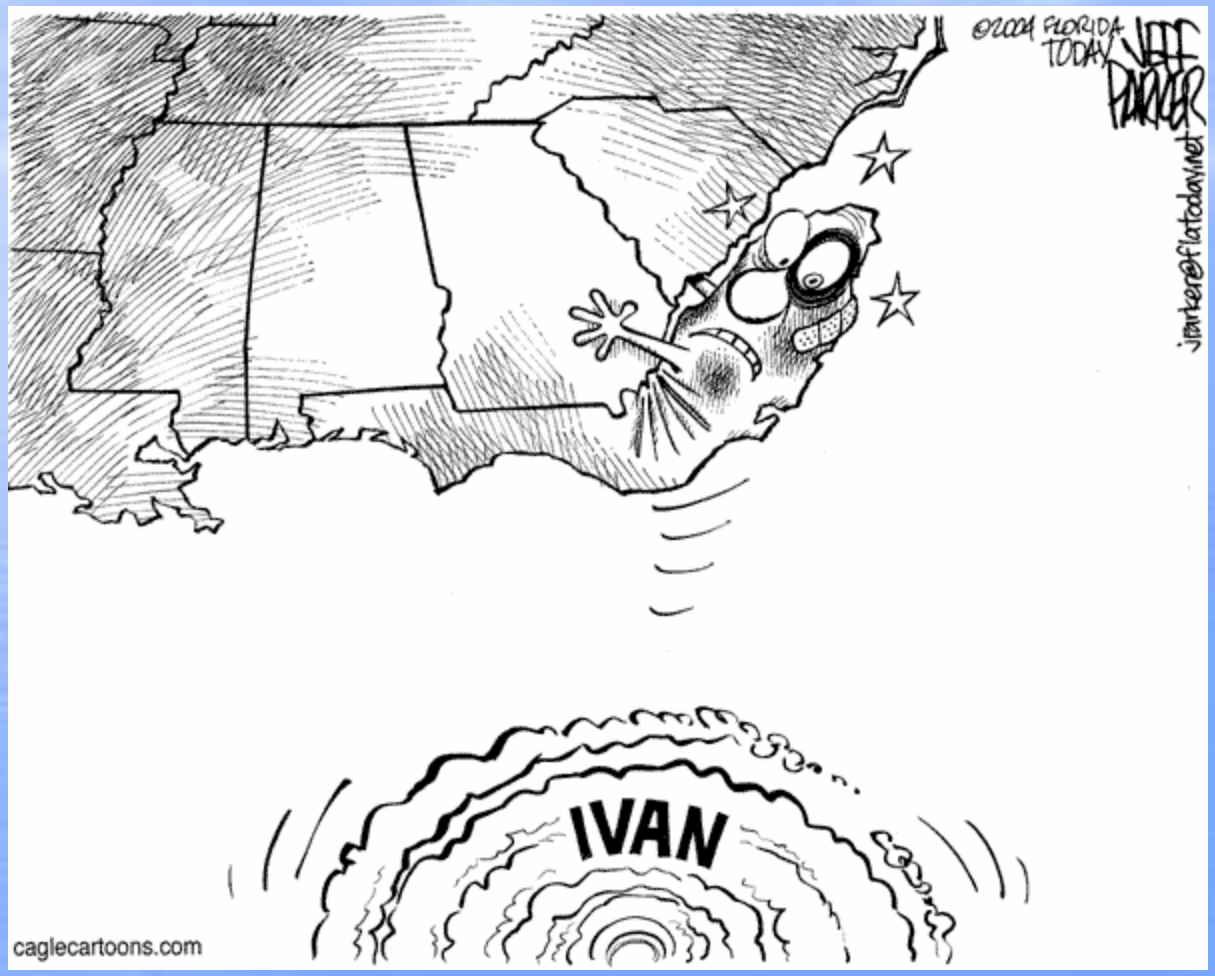
“Hybrid” Tropical Storm Mitch



Supercells Produce F2 Tornadoes in Keys 11/4/98

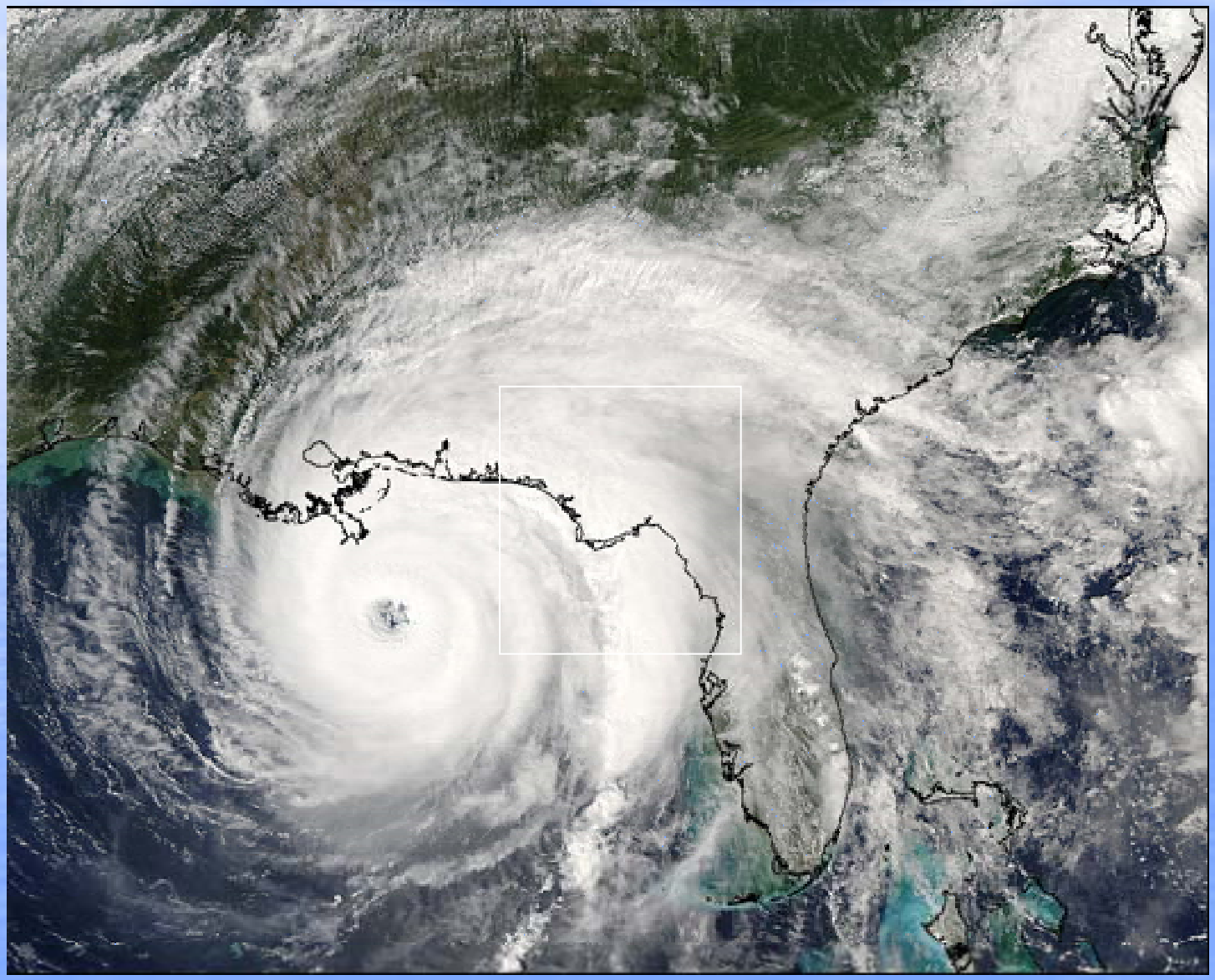


2004 Hurricane Season

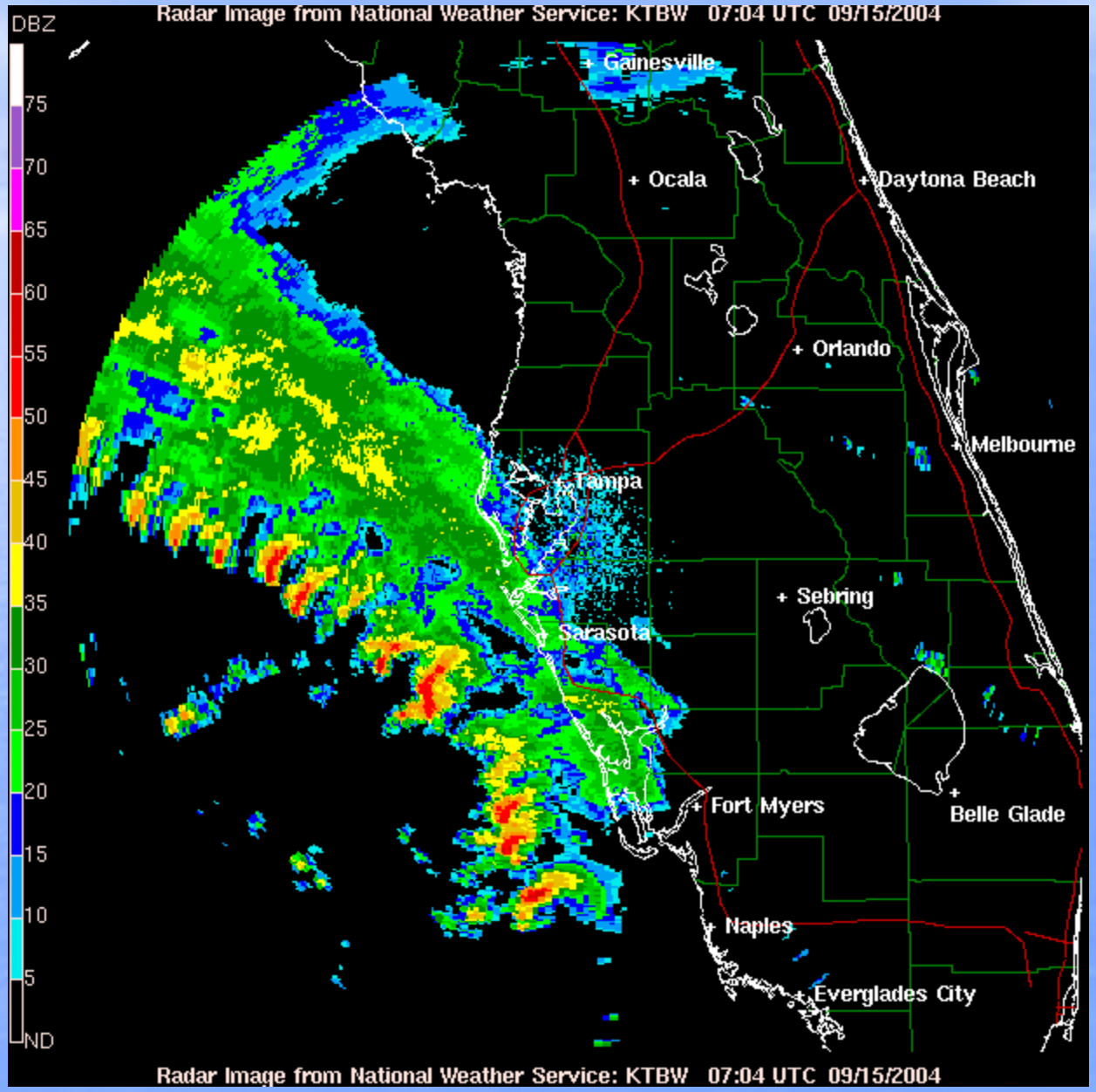


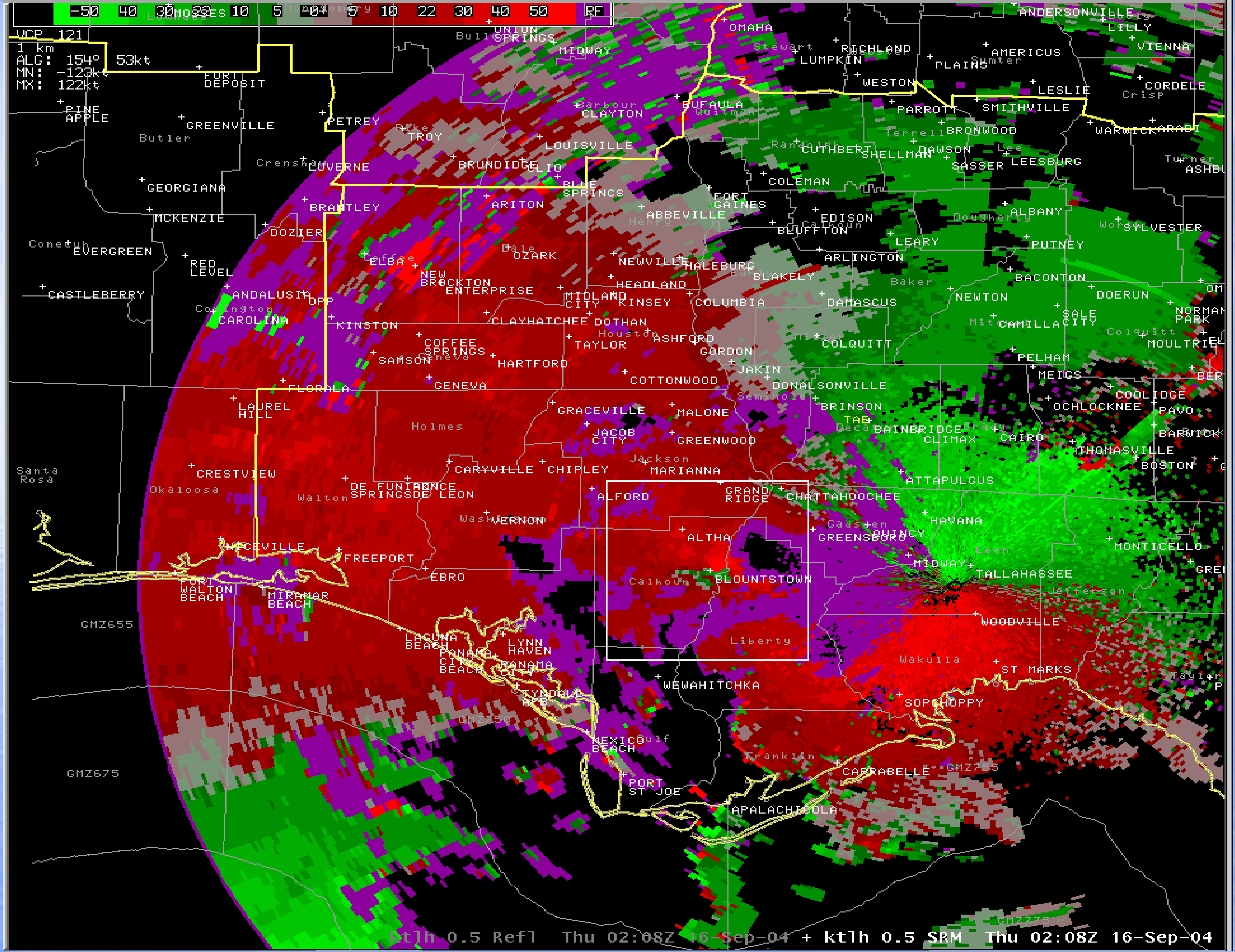
Ivan Images – Irv Watson WFO TLH

Hurricane Ivan
3 Killer Tornadoes - 2 F2 and 1 F1 – 6 Dead

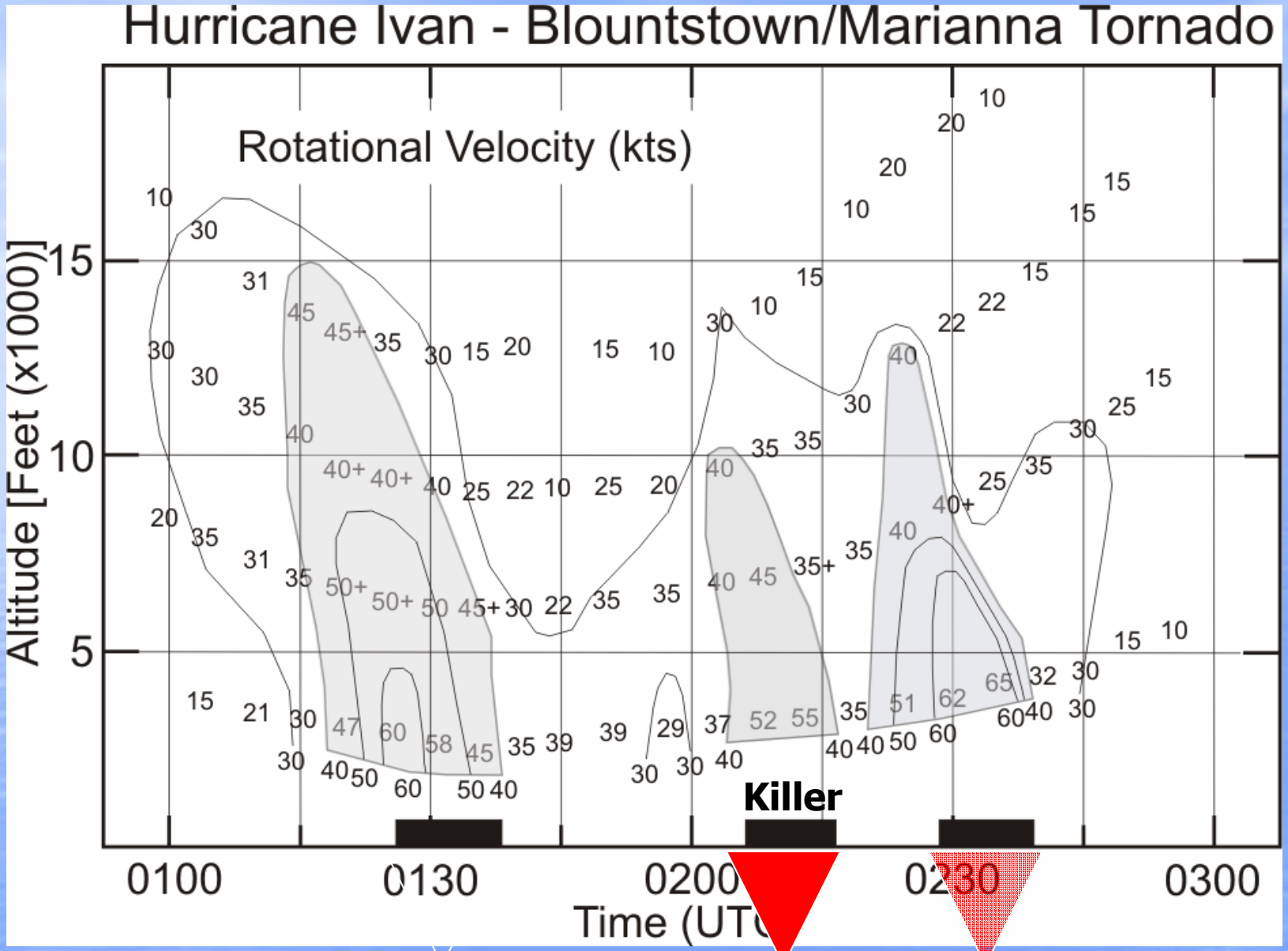


Dominant Outer Rainband Missed Peninsula!



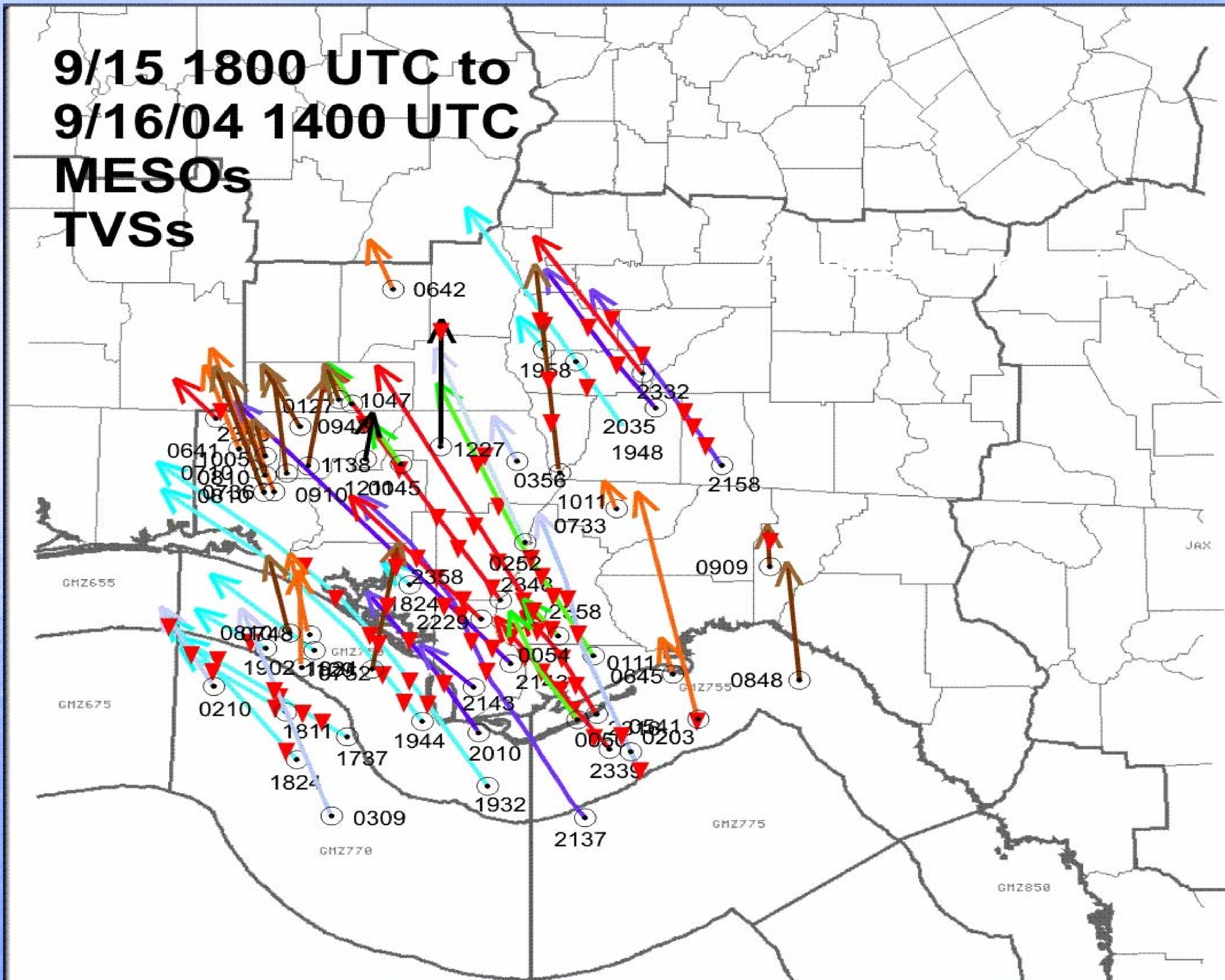


Four People Killed Near Blountstown (F2) 9/15/04 907PM

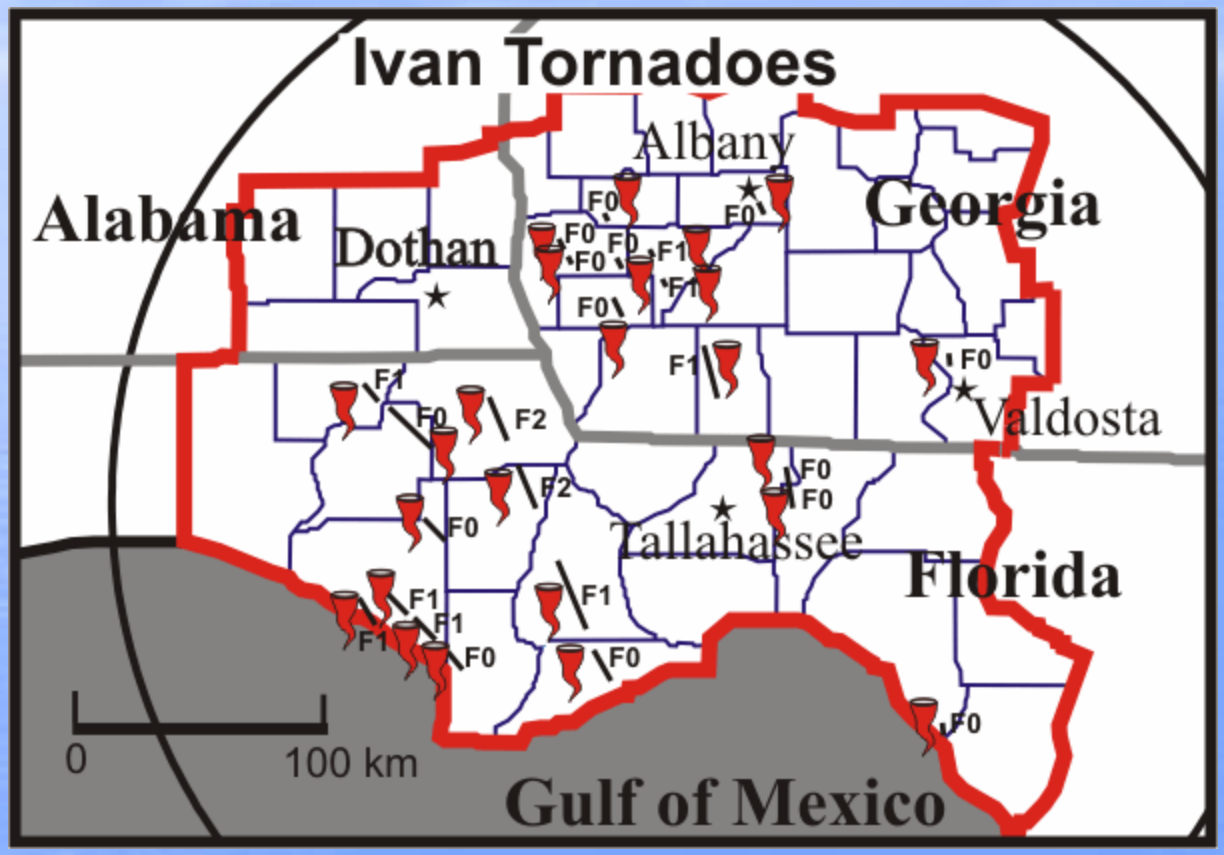


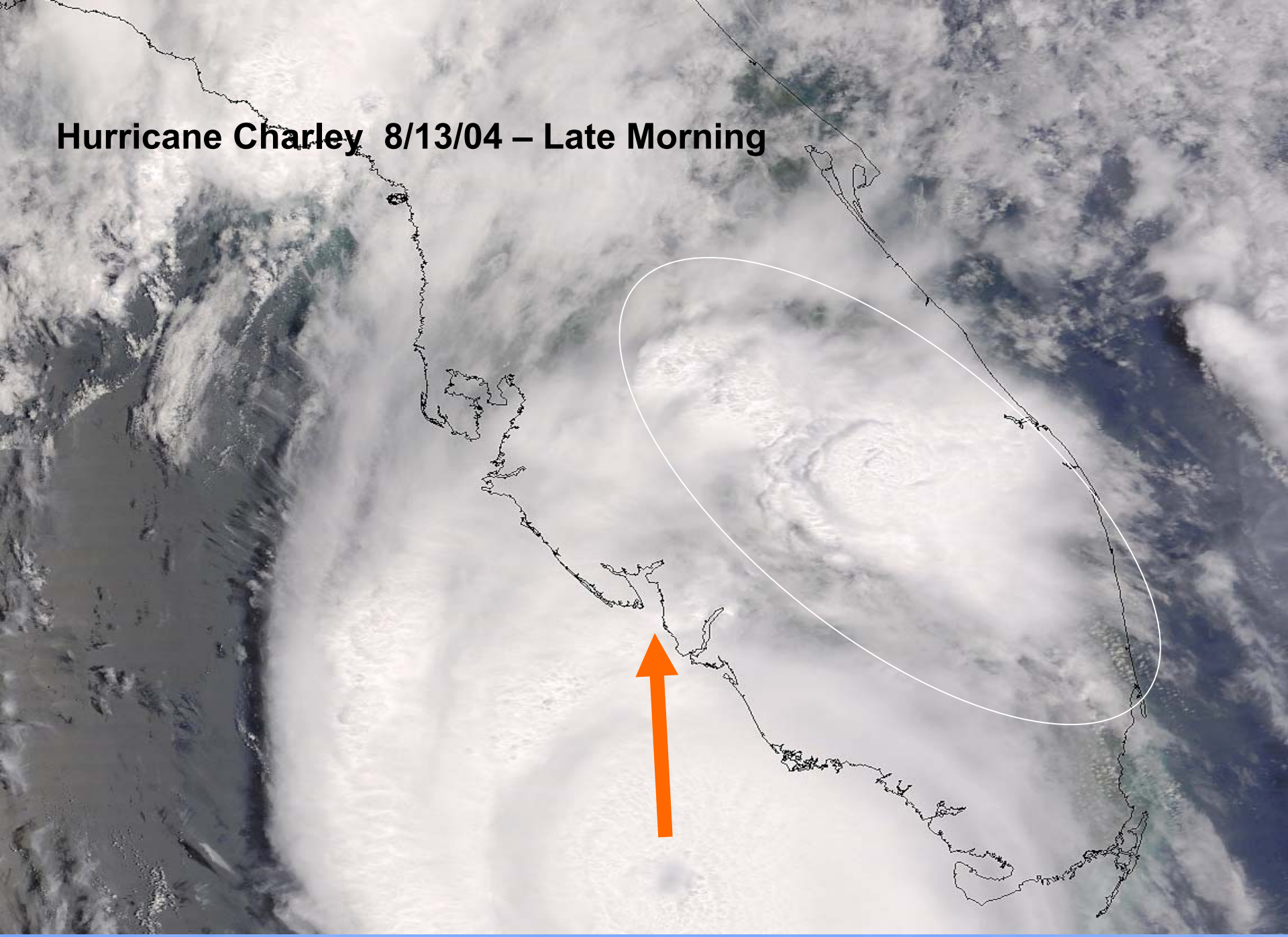
Irv Watson WFO TLH

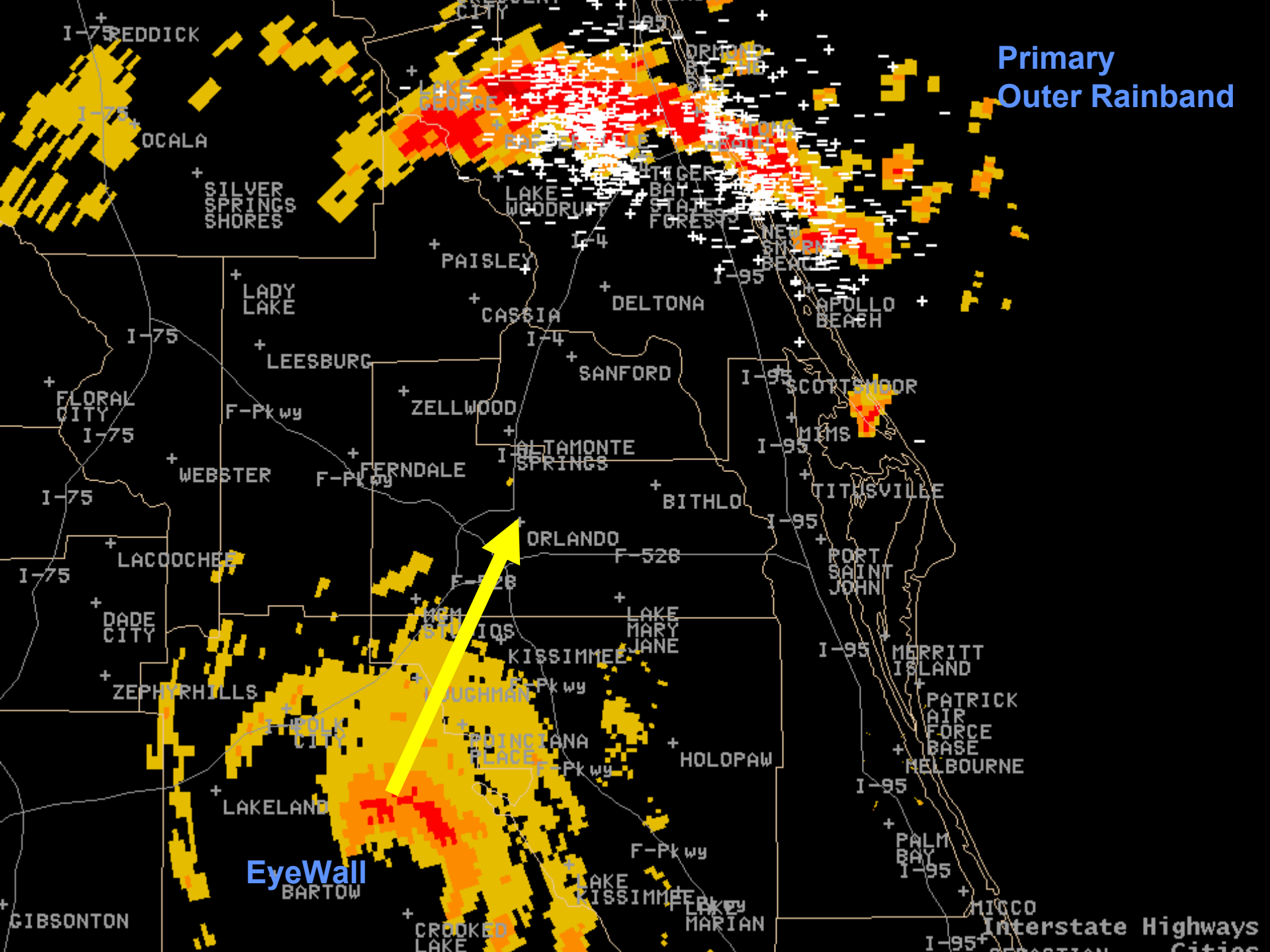
9/15 1800 UTC to 9/16/04 1400 UTC MESOs TVSs



Ivan Tornadoes in TLH Warning Area




Hurricane Charley 8/13/04 – Late Morning

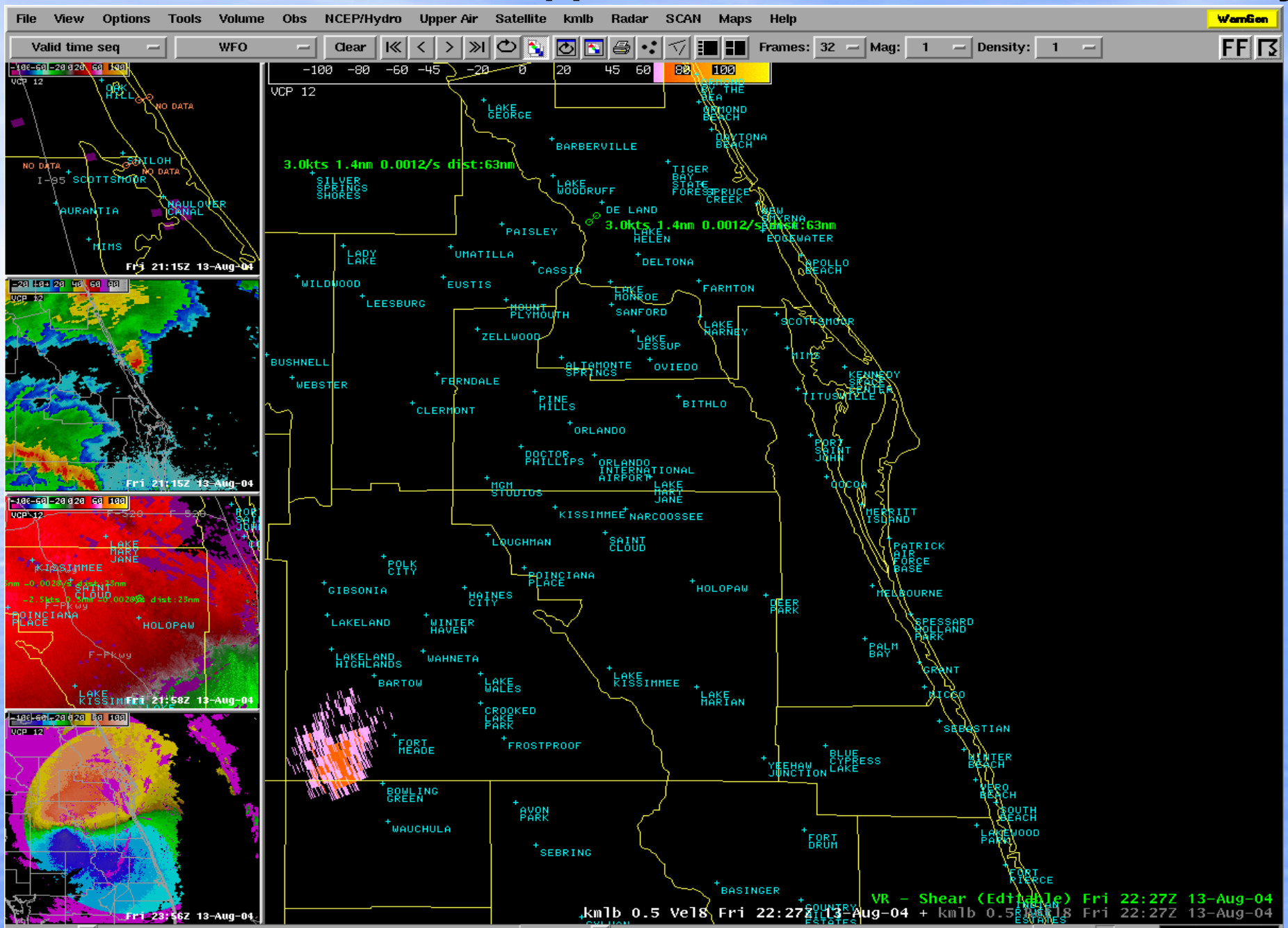

Primary
Outer Rainband
EyeWall
Interstate Highways
REDDICK
OCALA
SILVER SPRINGS SHORES
LADY LAKE
LEESBURG
FLORAL CITY
WEBSTER
FERNDALE
ZELLWOOD
PAISLEY
CASSIA
DELTONA
SANFORD
ALTAMONTE SPRINGS
BITHLO
ORLANDO
LACOOCHEE
DADE CITY
ZEPHYRHILLS
LAKELAND
BARTOW
GIBSONTON
CROOKED LAKE
KISSIMMEE
LAKE MARY JANE
HOLOPAW
MARIAN
APOLLO BEACH
SCOTTSMOOR
MIMS
TITUSVILLE
PORT SAINT JOHN
MERRITT ISLAND
PATRICK AIR FORCE BASE
MELBOURNE
PALM BAY
MICCO
I-75
I-4
I-95
F-Pkwy
F-528

BULLETIN - EAS ACTIVATION REQUESTED
TORNADO WARNING

***AT 642 PM EDT...THE NATIONAL WEATHER SERVICE HAS ISSUED A TORNADO WARNING FOR DESTRUCTIVE WINDS OVER 100 MPH AND TORNADOES IN THE EYE WALL AND INNER RAIN BANDS OF HURRICANE CHARLEY.**

*** THE LEADING EDGE OF HURRICANE CHARLEYS DESTRUCTIVE WINDS IS EXPECTED TO MOVE INTO THE KISSIMMEE AND GREATER ORLANDO AREA BY 715 PM.**

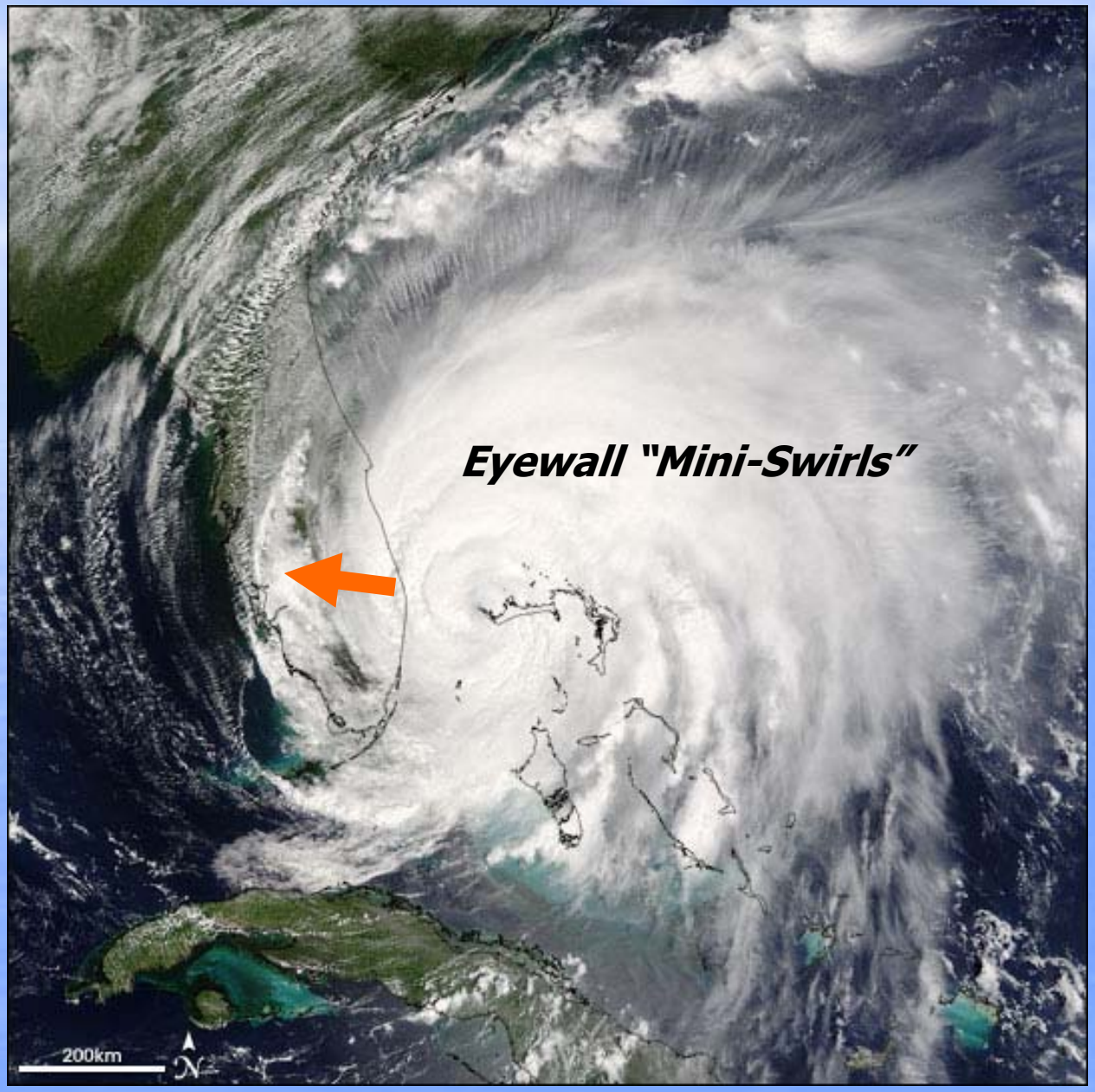
64 -100+ Knot Doppler Measured Winds With Charley



The Eyewall and innermost rainbands of landfalling hurricanes are extremely dangerous phenomena that produce very localized devastation!

Charley – Metro Orlando

Hurricane Jeanne 25 SEP 2004



Conceptual Model of Hurricane Eyewall "Mini-Swirls"

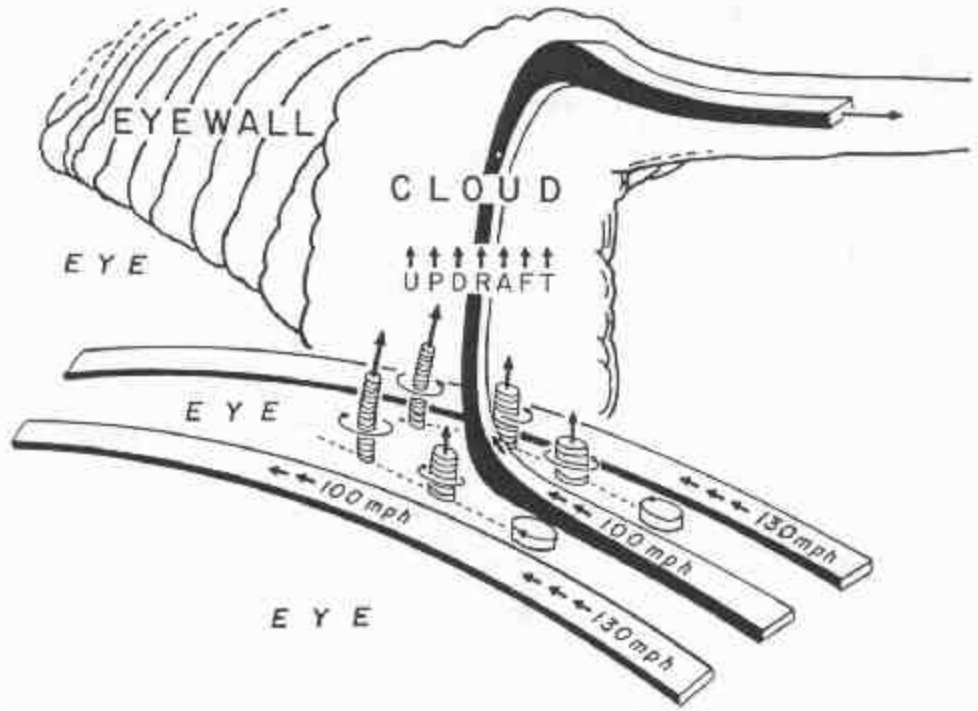


Figure 308. Mini-swirls in a hurricane

According to Professor Fujita, wind shear zones are set up within the eye wall, because different parts of the eyewall rotate at different speeds. The wind shear gives rise to areas of rotation along a vertical axis. If those areas of rotation coincide with an updraft, the mini-swirls spin up and move rapidly forward with the intensity of a strong to (possibly) violent tornado. Drawing courtesy of Professor Ted Fujita.

BULLETIN - EAS ACTIVATION REQUESTED

TORNADO WARNING

NATIONAL WEATHER SERVICE MELBOURNE FL

858 PM EDT SAT SEP 25 2004

THE NATIONAL WEATHER SERVICE IN MELBOURNE HAS ISSUED A

*** TORNADO WARNING FOR...**

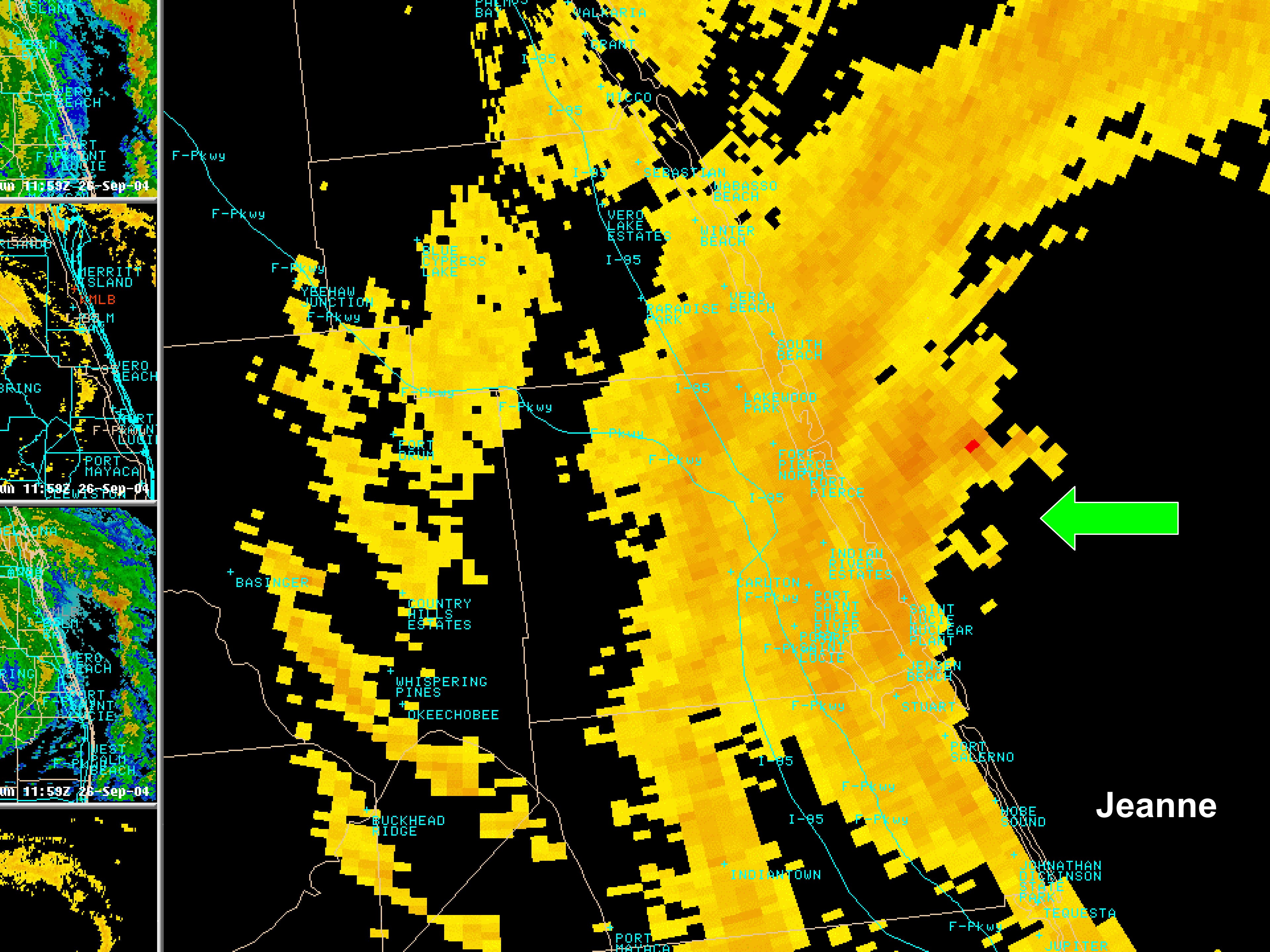
MARTIN COUNTY

ST. LUCIE COUNTY

IN EAST CENTRAL FLORIDA

*** UNTIL 1000 PM EDT**

*** AT 855 PM EDT...THE NATIONAL WEATHER SERVICE HAS ISSUED A TORNADO WARNING FOR MARTIN AND ST LUCIE COUNTIES MAINLY FOR THE ONSET OF EXTREME HURRICANE WINDS AND EMBEDDED TORNADOES ASSOCIATED WITH THE INNER CORE OF HURRICANE JEANNE AS THE CENTER NEARS THE COAST. WINDS TO 100 MPH WITH GUSTS TO 120 MPH ARE EXPECTED...ALONG WITH TORNADOES.**



Jeanne
VALKARIA
GRANT
MICCO
SEBASTIAN
WABASSO BEACH
VERO LAKE ESTATES
WINTER BEACH
BLUE CYPRESS LAKE
YEEHAW JUNCTION
PARADISE PARK
VERO BEACH
SOUTH BEACH
LAKEWOOD PARK
FORT DRUM
FORT PIERCE
FORT PIERCE NORTH
INDIAN RIVER ESTATES
BASINGER
COUNTRY HILLS ESTATES
PORT SAINT LUCIE RIVER PARK
SAINT LUCIE NUCLEAR PLANT
JENSEN BEACH
WHISPERING PINES
OKEECHOBEE
STUART
PORT SALERNO
BUCKHEAD RIDGE
HOBE SOUND
INDIANTOWN
JOHNATHAN DICKINSON STATE PARK
TEQUESTA
JUPITER
I-95
F-Pkwy
11:59Z 26-Sep-04


STOP

Survey results -Jeanne

One Lucky Row of Manufactured Homes – Near Barefoot Bay

Eyewall "Mini-swirls"

And Some Not so Fortunate

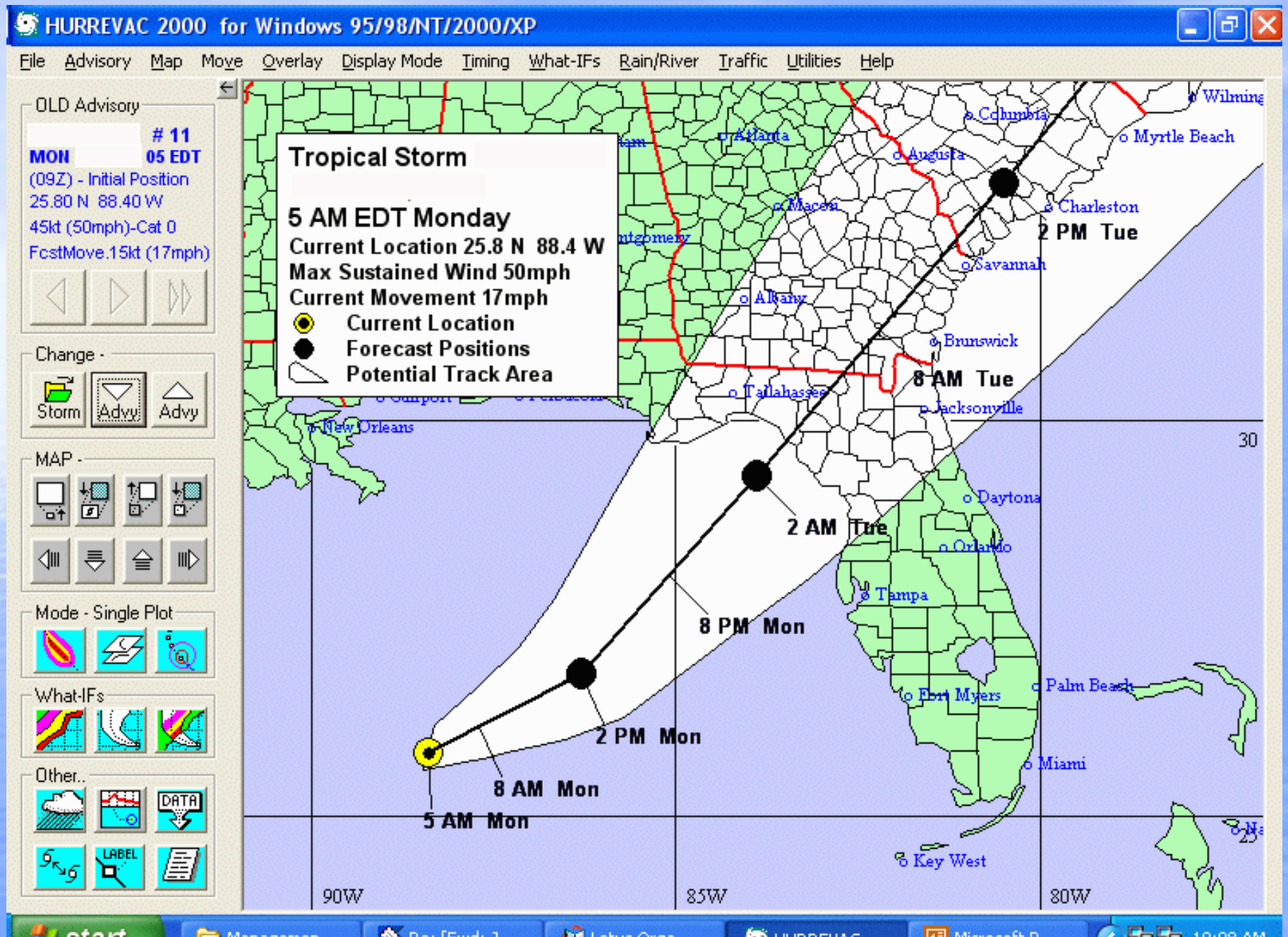
- Damage gradient extreme, destruction localized – county scale.
- Historic severe weather events where they occur.
- Hurricane Warnings may have been out for 24 hours or more.

- Power may be out and information lacking just before the worst hits.
- Citizens need final warning – last chance to save lives ~ 1-2 Hours. Need EAS.
- Not talking about track – but impact!
- Temporary Solution in 2005 Season

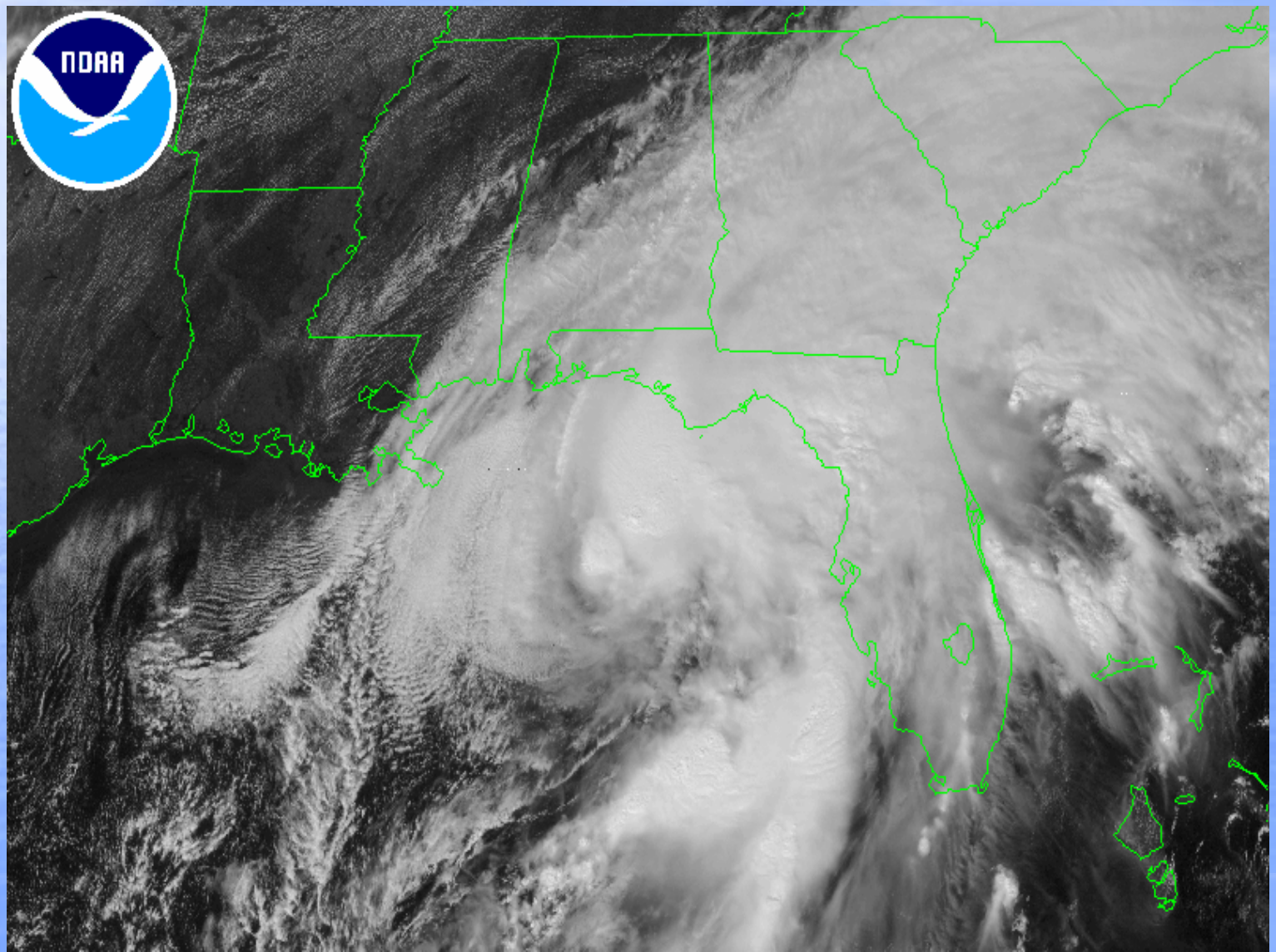
Exercises:
Predict Tornado Locations and Maximum Strength!

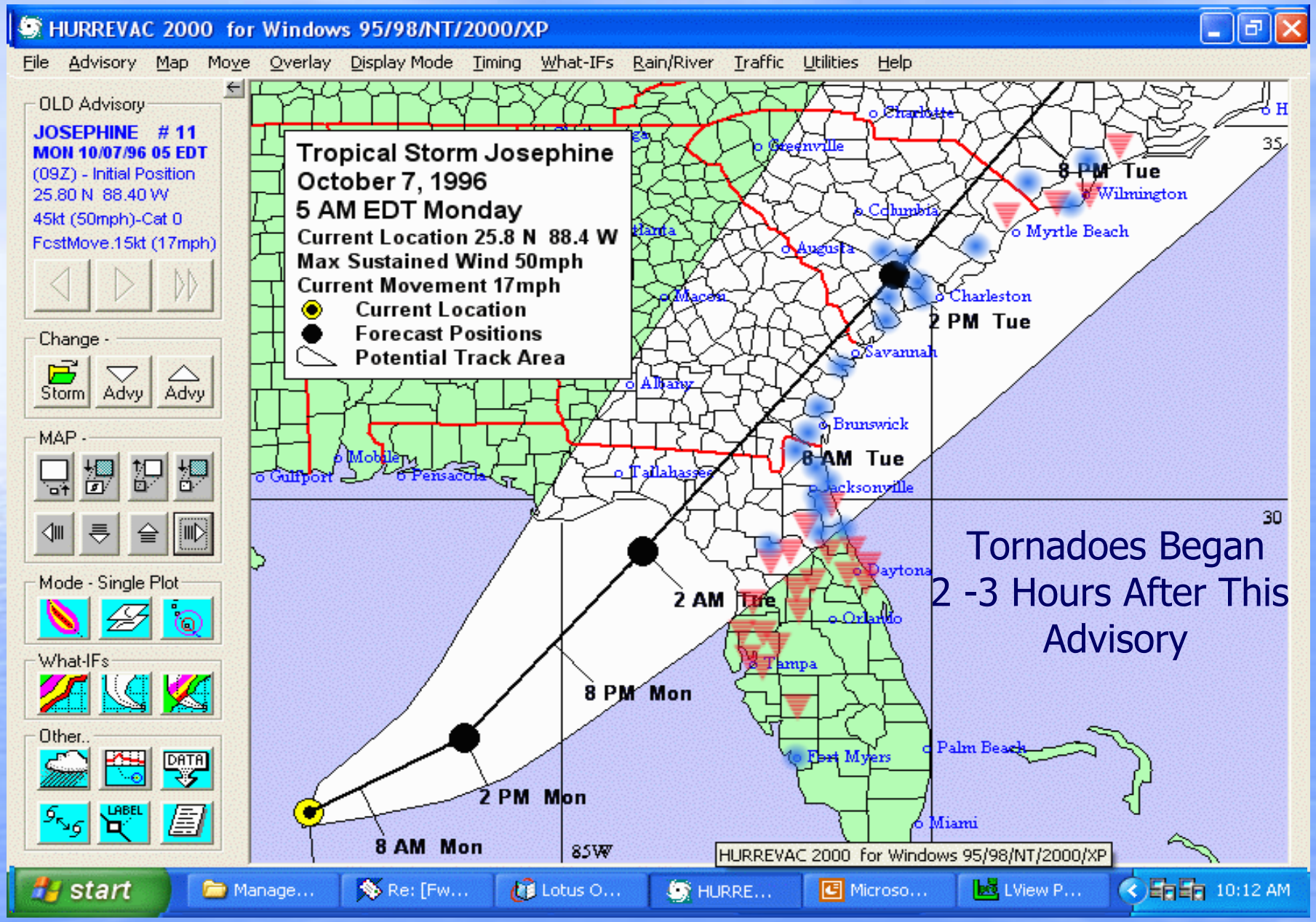
Case #1

Where Will Tornadoes Strike within the Next 24-36 Hours?



Shade the Counties Where Tornadoes Will Strike Within the Next 24-36 Hours and Estimate How Soon After the Advisory They Will Begin?




HURREVAC 2000 for Windows 95/98/NT/2000/XP
File Advisory Map Move Overlay Display Mode Timing What-IFs Rain/River Traffic Utilities Help
OLD Advisory
JOSEPHINE # 11
MON 10/07/96 05 EDT
(09Z) - Initial Position
25.80 N 88.40 W
45kt (50mph)-Cat 0
FcstMove.15kt (17mph)
Change -
Storm
Advy
Advy
MAP -
Mode - Single Plot
What-IFs
Other..
DATA
LABEL
Tropical Storm Josephine
October 7, 1996
5 AM EDT Monday
Current Location 25.8 N 88.4 W
Max Sustained Wind 50mph
Current Movement 17mph
Current Location
Forecast Positions
Potential Track Area
8 AM Mon
2 PM Mon
8 PM Mon
2 AM Tue
8 AM Tue
2 PM Tue
8 PM Tue
Tornadoes Began
2 -3 Hours After This
Advisory
Charlotte
Greenville
Columbia
Augusta
Wilmington
Myrtle Beach
Charleston
Savannah
Brunswick
Jacksonville
Daytona
Orlando
Tampa
Fort Myers
Palm Beach
Miami
Macon
Albany
Tallahassee
Mobile
Pensacola
Gulfport
35
30
85W
HURREVAC 2000 for Windows 95/98/NT/2000/XP
start
Manage...
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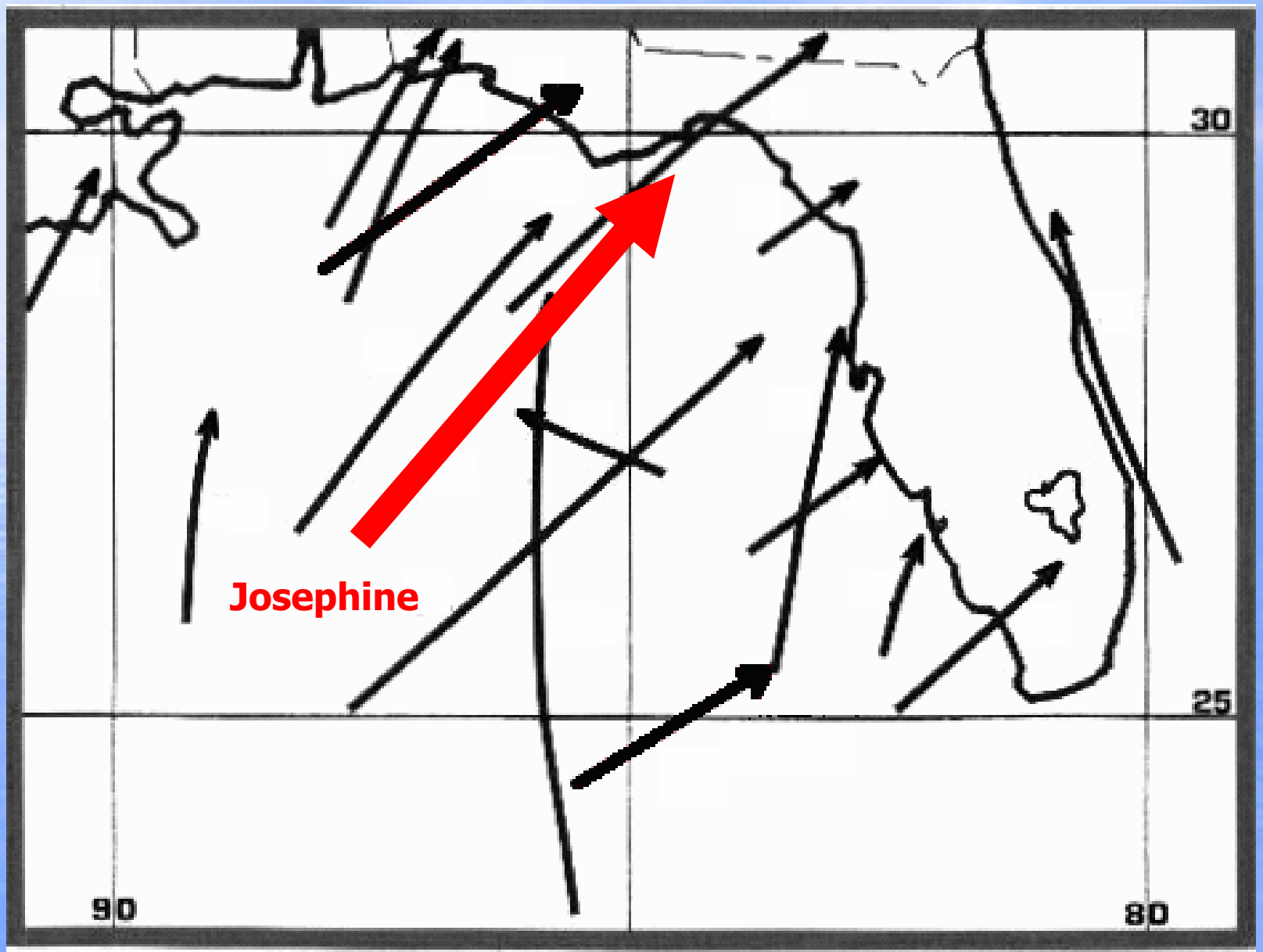
HURRE...
Microso...
LView P...
10:12 AM

Significant Tornado Outbreaks



Josephine rolls across Florida with rain, tornadoes

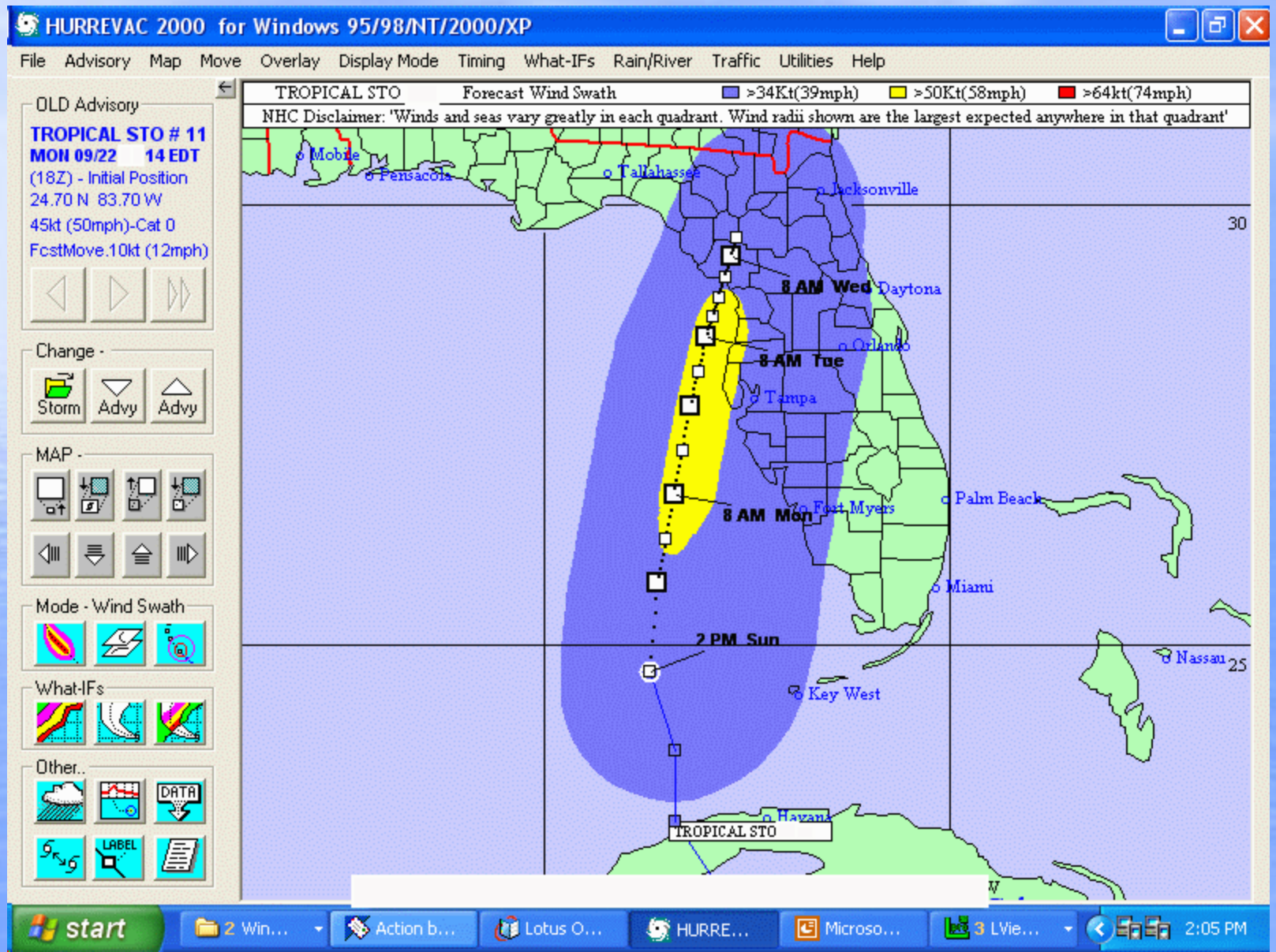
October 8, 1996
Web posted at: 8:15 a.m. EDT

ST. MARKS, Florida (CNN)-- Tropical storm Josephine, with 65

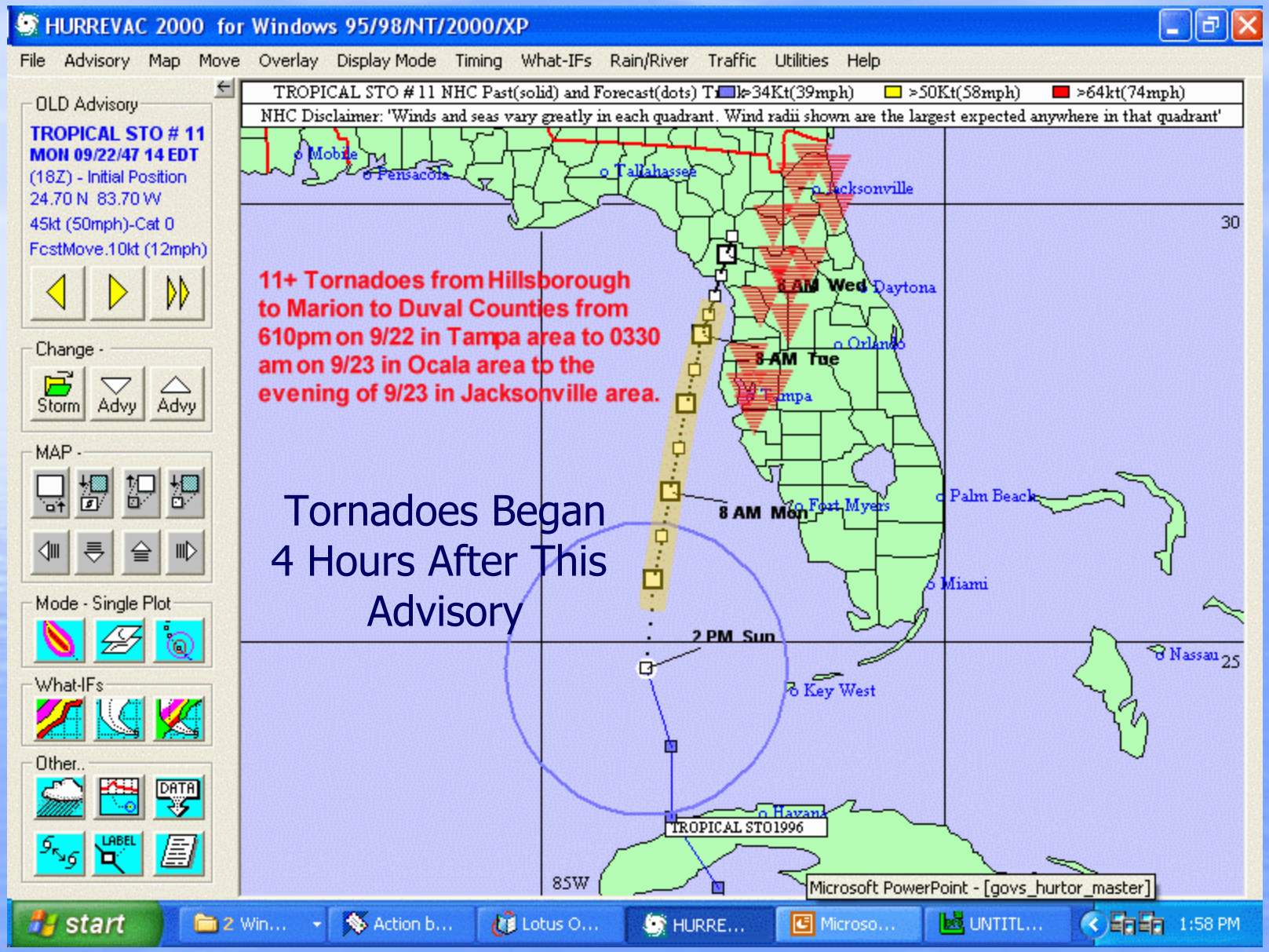
Edgewater, Florida (Courtesy WCPX)

Case 2

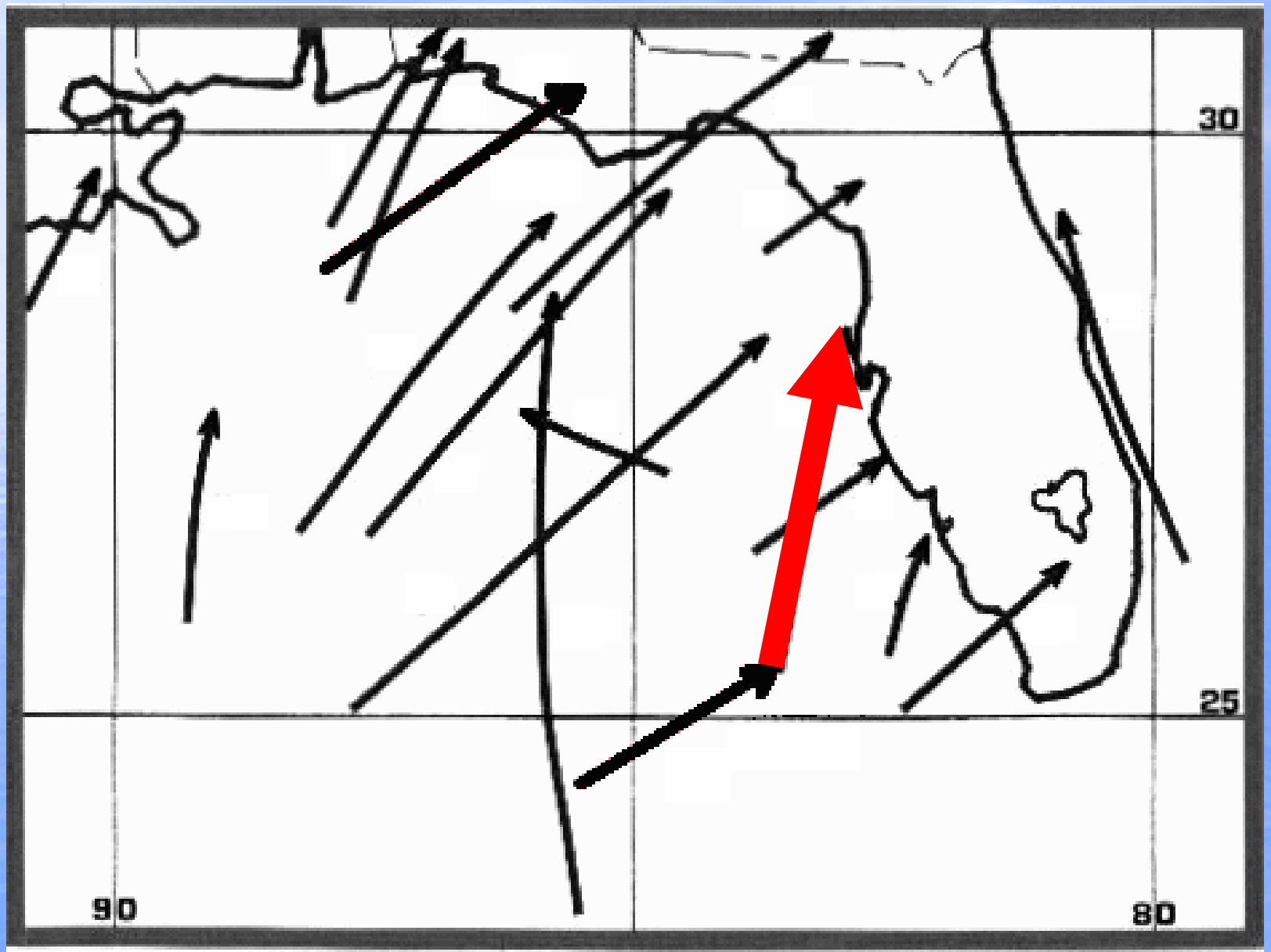
Shade the Counties Where Tornadoes Will Strike Within the Next 24-36 Hours and Estimate How Soon After the Advisory They Will Begin?



September 22-23 1947

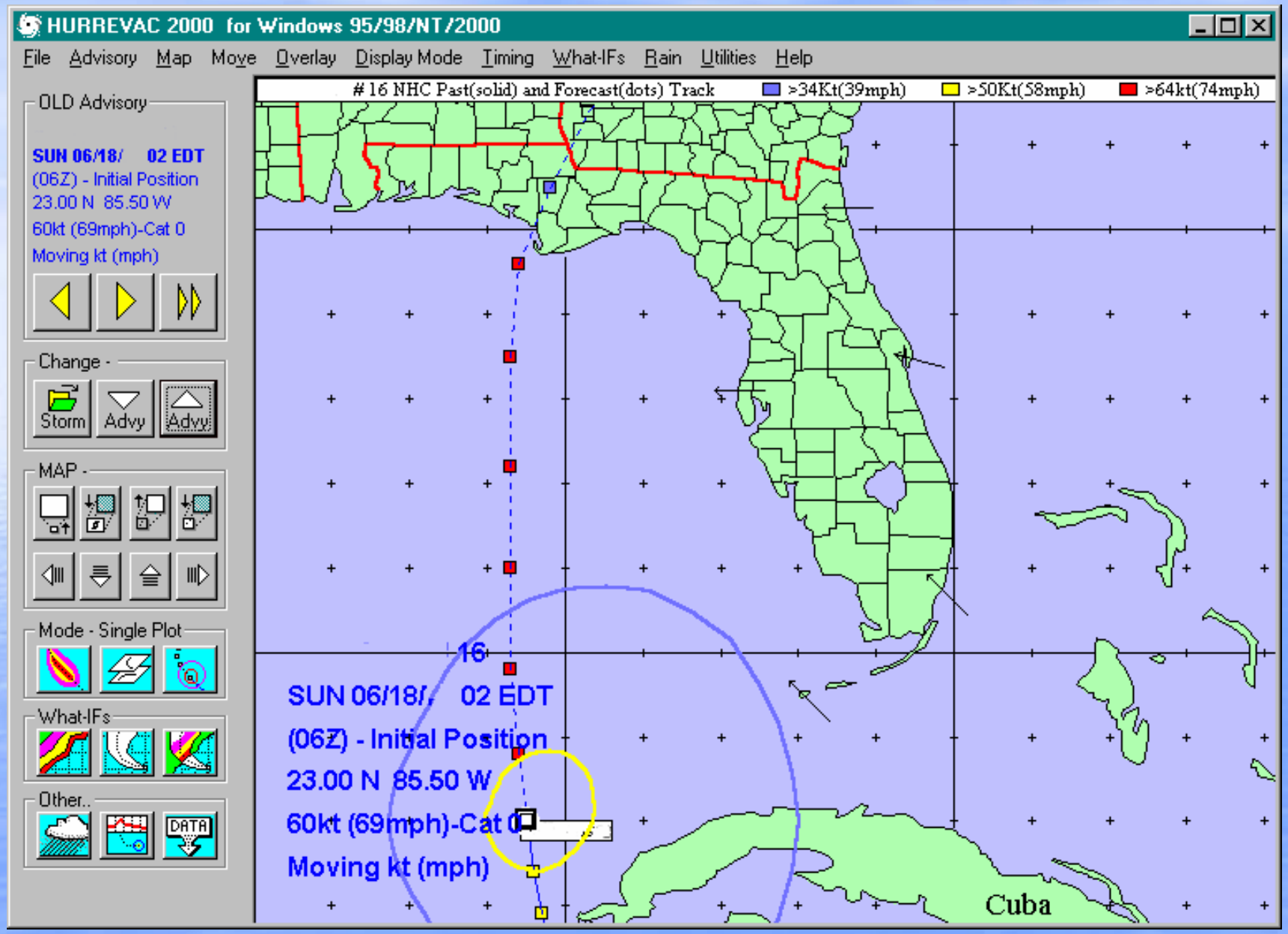


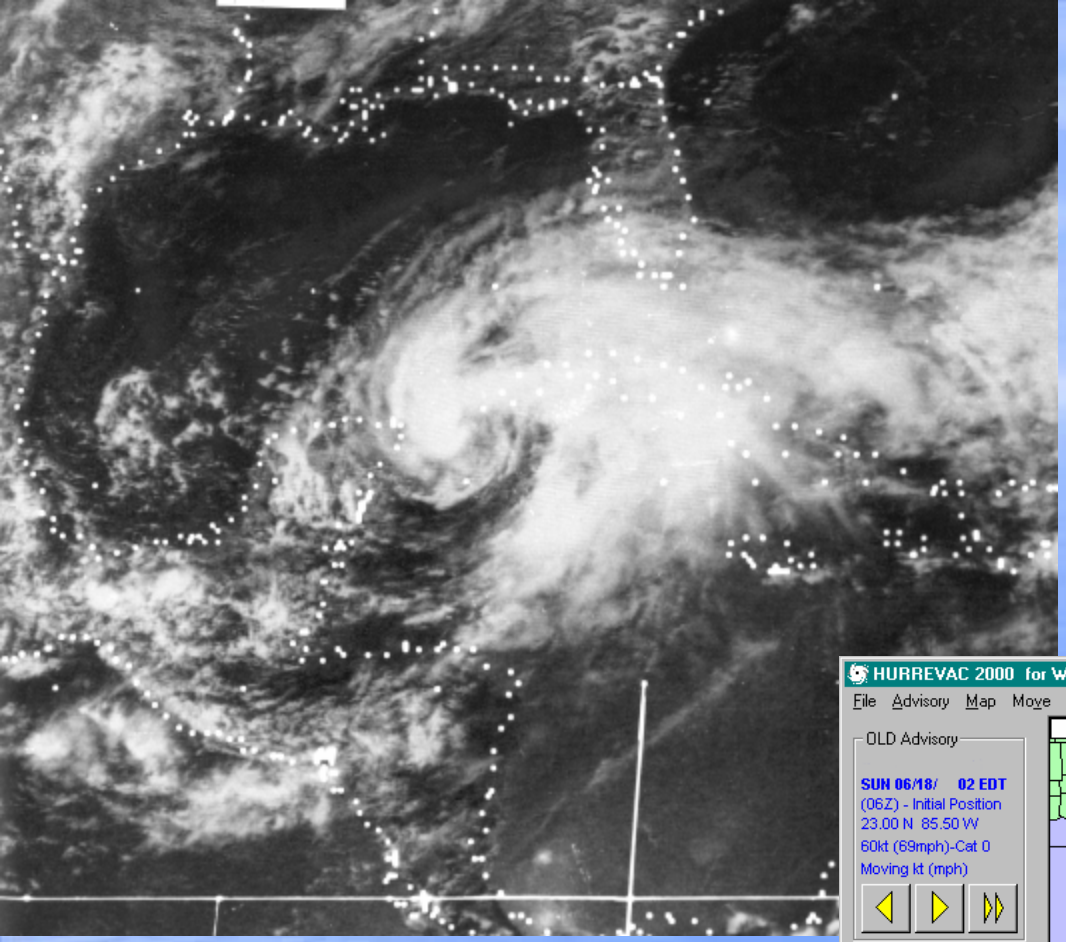
Significant Tornado Outbreaks



Case 3

Where Will Tornadoes Strike within the Next 24-36 Hours?





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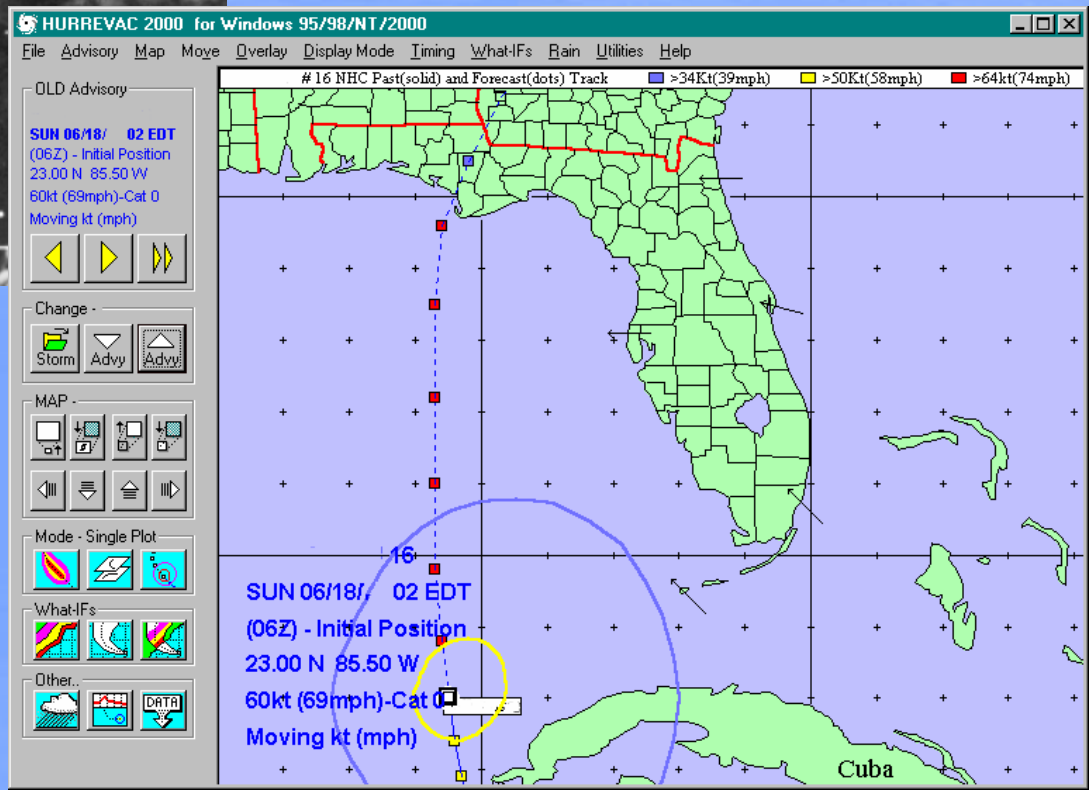
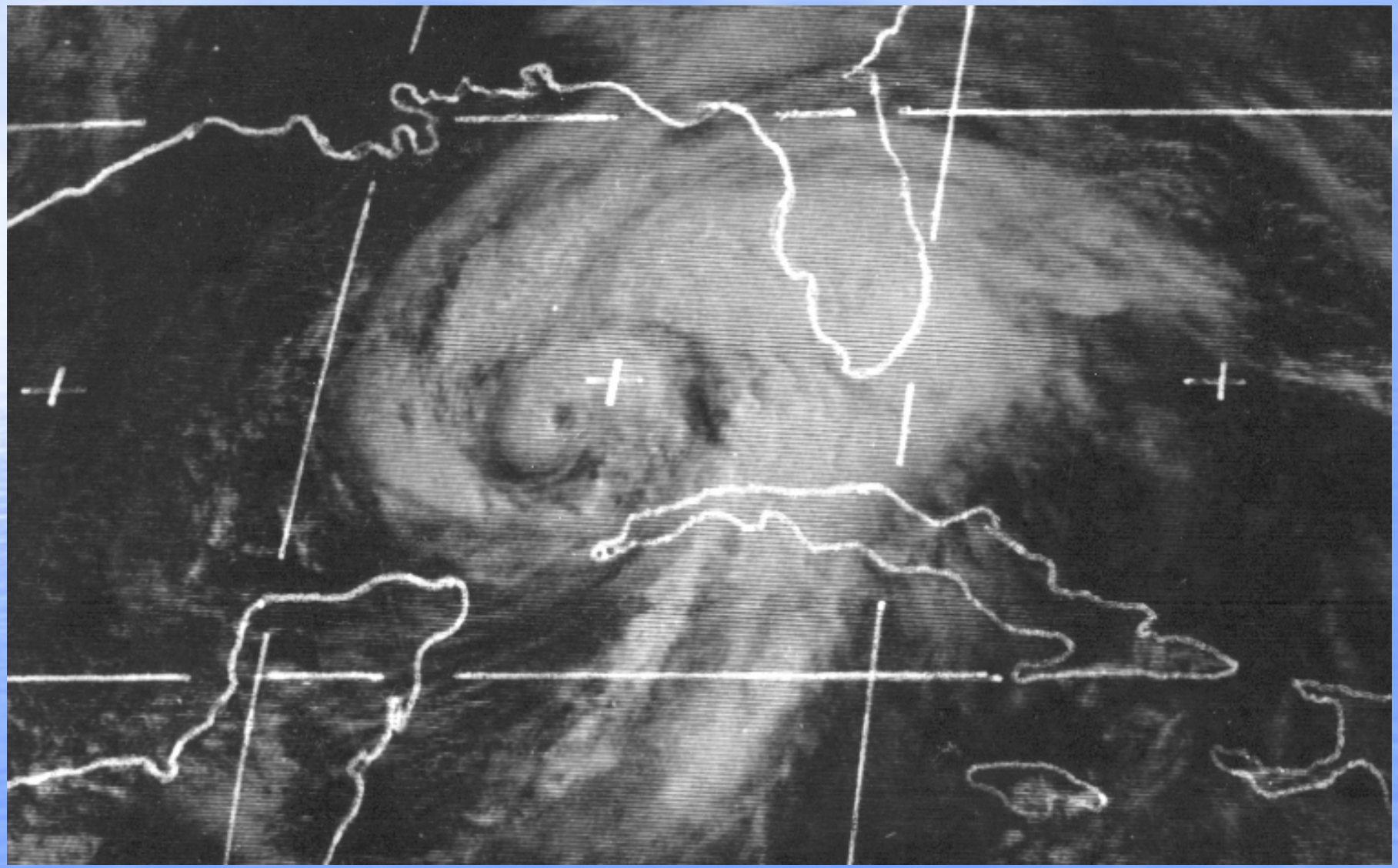


CLUE - Category 1 Hurricane – No Strengthening Forecasted



6—The Key West Citizen Monday, June 19, 1972

Tornado rips path across Key West

Photos by Wendy Tucker

Big Coppitt Key: sudden devastation, terror in darkness

Savage

Funnel Cloud Over Cape Coral

...ge in Cape Coral from Hurricane Agnes was caused primarily by tor-...ped out of the cloud and rain shield spreading over the city from the ...s at sea. This photo shows one dark funnel cloud spinning over a Cape ...nday afternoon as it moved northward with a squall line. (BREEZE ... Kirkpatrick)

Tornadoes Began 15 minutes after Advisory

TODAY

Florida's Space Age Newspaper

Published by The Gannett Company in Brevard County, Florida

Next Space Shot

An Orbiting Astronomical Observatory will go Aug. 10 on an Atlas-Centaur rocket.

TODAY's Weather

Cloudy, showers. High mid-80s, low mid-70s. Winds east-southeast 20-25 m.p.h. (Complete weather Page 2A)

10 Cents

Eleven Hurt as Tornado Slams South Brevard

● Photos on back page this

Brevard Hospital. Most in- noise," said Paul Brown, 44, trailer was demolished."

trailer was blown in on him.

AP Cpl. Bill Mathews

ach Post

Awards

Pyle Kennedy Palmer

JUNE 10, 1972 ● 44 PAGES -- PRICE TEN CENTS

Evacuation Urged in Low Area of Panhandle

Related stories, A2, C1

Picking Through the Rubble, 'It Sounded Like a Freight Train Was Coming,' Said One

Residents of a low-lying area along a strip of the Florida Panhandle were urged to evacuate yesterday as Hurricane Agnes churned toward them with winds up to 100 miles an hour and tornadoes that killed one person and injured at least 35.

As the season's first hurricane plodded north at about 12 m.p.h. from a position 270 miles south of Panama City, the National Hurricane Center recommended evacuation of the offshore islands and beach areas along a 110-mile strip of the panhandle.

"Evacuation roads in this area are low, and some escape routes may be cut off by rising waters three to six hours before the center reaches the coast early this afternoon," the center's advisory said.

Police in the agricultural town of La Belle, about 80 miles northwest of Miami, said one woman was killed and several persons were injured when a tornado tore into a nearby residential section.

Civil Defense officials in Port St. Joe said 700 to 800 residents of low-lying sections of the town were being evacuated. Many of them were preparing to spend the night in a high school, according to the local CD chief, Richard Lancaster. He added that persons would be evacuated today to Marianna if conditions became worse.

The hurricane center said Agnes was expected to cross the Panhandle near Apalachicola early this afternoon if she maintained her course and speed.

"Everybody around here is boarding up their houses, and the boats are all being called into safe harbor," said Nick Fortunas, an officer of the Apalachicola Police Department.

"We've been pretty busy helping people board up and carrying radios to places where we think communications might be knocked out.

"Civil Defense, firemen, sheriff's deputies, notary service, everybody's been helping out," he said.

"It's lucky that not too many people here live on low-lying areas," Fortunas added. Apalachicola is a coastal town of about 3,500 persons.

Sixteen Cuban fishing boats had anchored just off Cedar Key within U.S. territorial waters to seek safety as Agnes approached, the Florida Marine Patrol reported.

Patrolman W. H. Wilson said in Crystal River that the patrol was notifying the U.S. Coast Guard that the Cuban boats had been observed from Cedar Key docks. No other action was being taken, he said.

The National Hurricane Center in Miami issued a 10 p.m. warning to persons living in low-lying areas along a 110-mile section of the Florida Panhandle to evacuate.

Agnes was centered then near Latitude 28.2 North, Longitude 85.7 West.

A spokesman for the Brevard Hospital in Melbourne said 12 people were treated for injuries sustained from a tornado which touched down at a nearby trailer park about 8 p.m.

Turn to HURRICANE, A2

Tornado Kills Woman Near La Belle

By DEAN JONES
and JAMES QUINLAN

LA BELLE, A tornado spawned by Hurricane Agnes flashed through trailer parks west of here yesterday, killing a housewife and injuring six other persons.

Witnesses said the twister toppled oak trees, ravaged citrus groves and hurled a pickup truck into a mobile home. It touched down on both sides of the Caloosahatchee River some 35 miles west of Clewiston.

At Fort Denaud on the south bank of the river, Mrs. Vickie Messer, about 30, was killed and her husband, Marion, injured when the twister demolished their trailer.

Civil defense authorities said 10-20 trailers were damaged or destroyed.

Mr. and Mrs. Emile LeClair, neighbors of the Messers in a nearby trailer, were at home at the time the twister struck.

"It sounded like a freight train was coming," Mrs. LeClair said.

Her husband who went outside said he stood in amazement as the tornado dropped out of the sky, clipped the tips of a dozen pine and oak trees and then "exploded" into the Messers' trailer.

"When it hit there was a flash and an explosion," LeClair said. "I ran over to the spot but there was nothing left. He (Messer) was standing over his wife when I got there. Buddy was just saying 'Please help me, please God help me.'"

Turn to LA BELLE, A2

FOR PEOPLE IN TROUBLE WE CARE INC.

Orlando Sentinel

'Tis a Privilege to Live in Central Florida

FINAL
Late Baseball

Vol. 88—No. 37 52 Pages Orlando, Florida, Tuesday, June 20, 1972 10 Cents

150 Homes Suffer Heavy Damage In Agnes Spinoff

3 Tornadoes Leave $12 Million Trail

BULLETIN

Alioto, Aides Acquitted

TACOMA, Wash. (AP) - A federal judge ordered acquittal Monday of San Francisco Mayor Joseph Alioto and two former Washington officials on charges that they conspired to bribe public officials.

Agnes Slows After Hitting Panhandle

APALACHICOLA (AP) — Hurricane Agnes smacked the Florida Panhandle with 80-mile-an-hour winds, heavy rains and raging seas Monday, but its fury started to subside as it churned inland.

At least 12 persons were left dead in the wake of the 1972 hurricane season's first storm. Forecasters said more deadly tornadoes or flash floods were possible.

THE NATIONAL Hurricane Center in Miami downgraded Agnes to a tropical storm Monday evening when its winds dropped below hurricane strength. Highest sustained winds were reported at 55 m.p.h. as the storm spent its energy in the Panhandle's piney woods.

But forecasters said Agnes threatened to spawn more tornadoes to the east as it moved north-northeast at 15 m.p.h.

Storm tides flooded streets in coastal towns along a 50-mile strip from Apalachicola to St. Marks in a popular fishing and tourist area.

FIVE DEATHS, and injuries to more than 100 persons in Florida, were attributed to tornadoes spawned by Agnes as she churned northward in the Gulf of Mexico. The storm earlier caused seven deaths by drowning in Cuba.

Coastal residents crowded into schools, armories and other sanctuaries prepared by civil defense and Red Cross workers.

RAGING WINDS from Agnes raked cornfields miles inland, and

SEARCH CONDUCTED FOR SALVAGEABLE

APPLEGATE FAMILY SEARCHES RUINS: Home hit at 415

24 Injured By Twisters

Partly cloudy with mainly afternoon showers and thundershowers. Rain probability 40 per cent. High 85-88. Low 74-78.

Details, A8

The Palm Beach Post

VOL. LXIV, NO. 92 WEST PALM BEACH, FLORIDA, TUESDAY MORNING, JUNE 20, 1972 36 PAGES—PRICE, TEN CENTS

Deadly Agnes Hits Panhandle, Fades

More Pictures, Stories, A4-5; Editorial, A10

Okeechobee Twister Kills 4; 44 Hurt

From Post Wire Services

APALACHICOLA — Hurricane Agnes hurled deadly tornados into inland Florida yesterday before smacking into the Florida Panhandle at midday with high tides and howling winds but its fury started to subside as it churned inland.

At least 12 persons were left dead — seven in Cuba, one in LaBelle and four in Okeechobee City — in the wake of the first hurricane of the 1972 season.

Forecasters said more tornados and flash floods were possible and much of the rest of the Deep South was placed under warnings as Agnes lost its hurricane status and was down graded to tropical storm at dusk when it was centered near Cape San Blas.

Damage was reported heavy at Apalachicola on the Gulf Coast and Cedar Key, west of Gainesville. Carabelle, a fishing village east of Apalachicola, was cut off by flood tides. One man was reported missing there, washed from his car by water raging across a highway.

Tides flooded streets along the coast in a 50-mile strip from Apalachicola to St. Marks in the popular fishing and tourist area.

Coastal residents crowded into schools, armories and other sanctuaries prepared by Civil Defense and Red Cross workers. They were urged to wait out the stalled storm, but most residents who had sought refuge returned to their homes as the winds subsided.

Turn to PANHANDLE, A4

By PAT CULLEN and DEAN JONES
Post Staff Writers

OKEECHOBEE — Four persons were killed and 44 others were injured, 25 seriously, when a tornado smashed through three mobile home parks near here yesterday.

"About 100 trailers were destroyed and at least another 100 were damaged," said Okeechobee County Sheriff's Chief Deputy Cliff Lightsey.

Three deaths occurred at Treasure Island, a mobile home park just off Taylor Creek. Seventy mobile homes, many of them in the $15,000 price range, were destroyed.

"We had just gone to bed," said Mrs. Robert Harris of Treasure Island. "Then we heard it — that horrible sound. My husband and I made a dash for the kids. But we never made it.

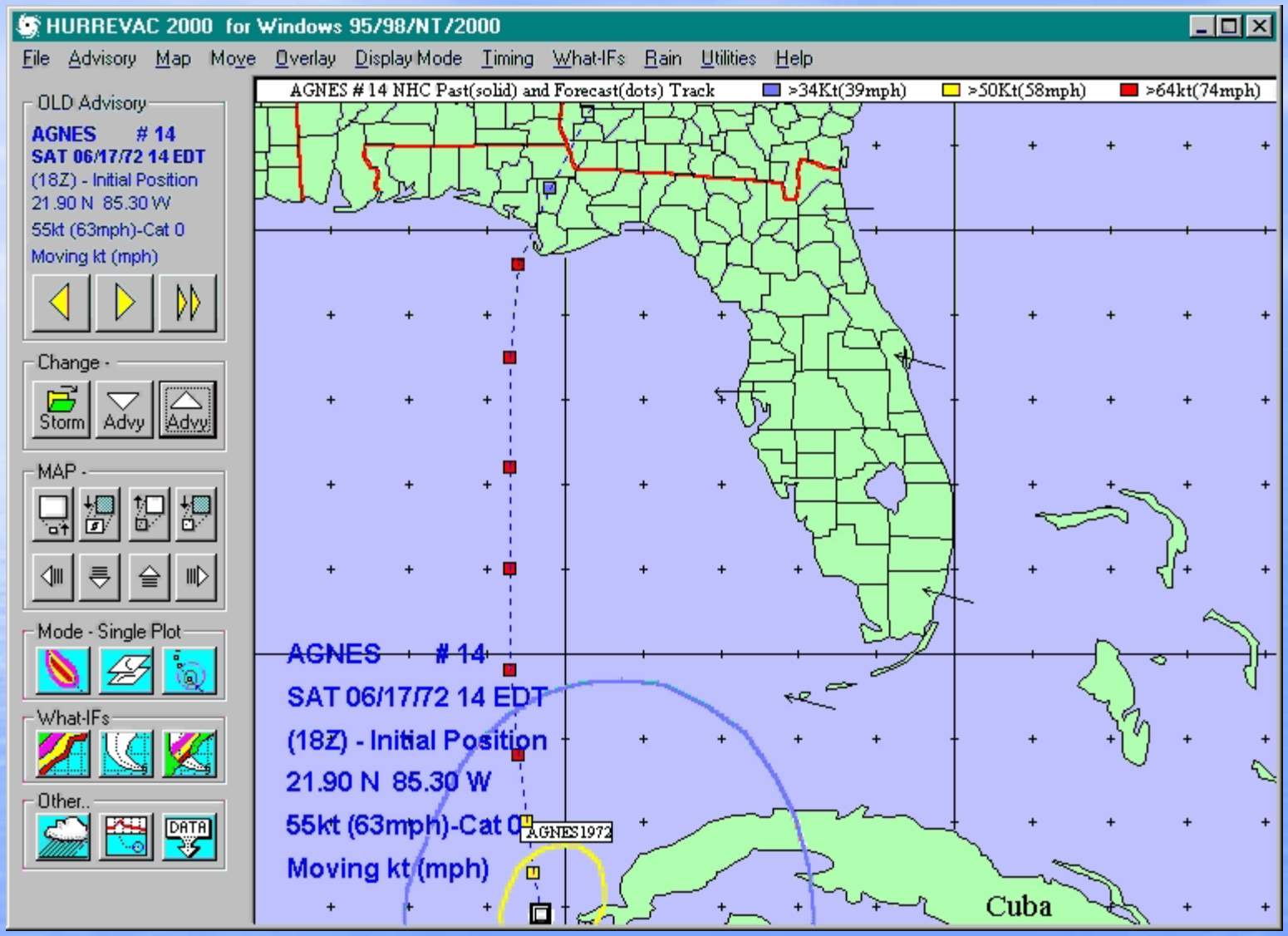
"We were running through the trailer, but then the next thing I remember, I was in the canal," said the woman, who suffered serious leg and rib injuries.

"I just knew I was going to drown, but I grabbed something. Maybe it was the edge of the trailer. Anyway, I held on very tight.

"Bob, he's my husband, he wound up in a boat. Don't ask me how . . . but he was thrown right into a boat."

Turn to TWISTER, A5

Hurricane Agnes June 1972



Deadliest Tropical Cyclone Tornado Outbreak in Florida History...28 Tornadoes in 26 hours... (2 F3, 9F2, 11 F1, 6 F0), including several tornado families and 7 reports of severe thunderstorms 2 tornadoes killed 7 and 10 tornadoes injured 140...

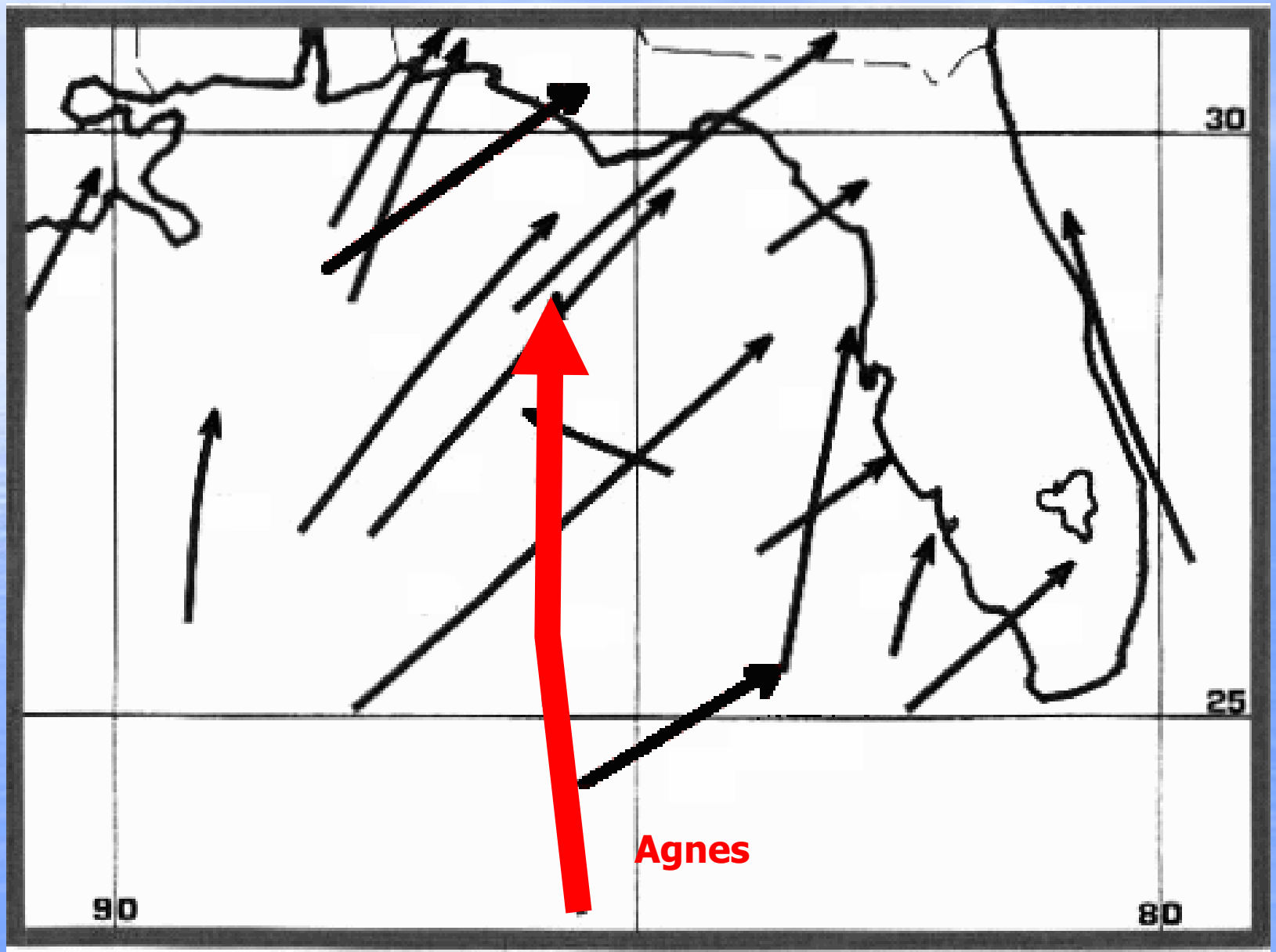
Agnes produced the most tornadoes, the most F2 and greater tornadoes, and the most death and injury producing tornadoes (10) of any outbreak in Florida history.

Agnes is the 4th deadliest tornado outbreak in Florida history.

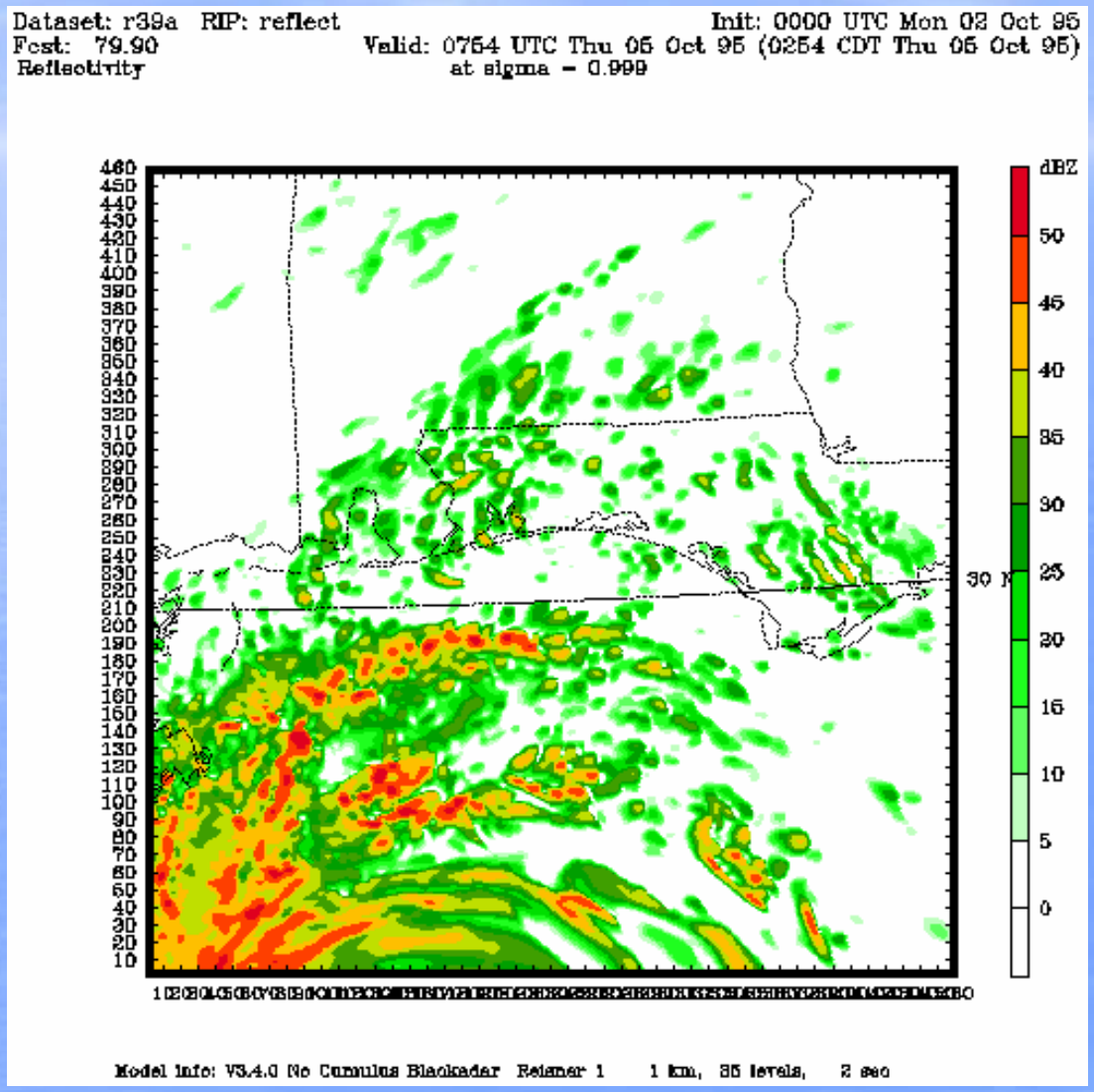
Agnes is the largest and deadliest TC tornado outbreak in Florida history and, in fact, the third deadliest in U.S. history since 1900, eclipsed only by Hilda in October 1964 (22 dead) and Carla in September 1961 (13 dead) - both post-landfall outbreaks from Gulf of Mexico TC's.

Agnes stands alone as the deadliest pre-landfall TC tornado outbreak in the recorded history of the U.S.

Significant Tornado Outbreaks



The Future
Mesoscale Modeling



Hurricane Opal (10/95) MM5 Radar Reflectivity Simulation

Concluding Thoughts

We Now Know a Lot About Tornadoes and Tropical Cyclones...but Major Issues Remain.

There is no reason to believe that in the future, a TC tornado outbreak could not kill more people than the February 1998 Extratropical Outbreak (42).

Remembering Agnes (and now Ivan) is useful as a planning metric – The outer rainband tornado archetype – to help realize what is possible.

Forecast ability has improved significantly: Tornado Watches are put up for most tropical cyclones. Tornado Warnings must be taken seriously, but potential for false alarms can be high in some cases. In other cases tornadoes can spin up rapidly with little warning.

The ability to separate the typical TC tornado from the truly dangerous outbreaks is not nearly so advanced. High resolution models and continued research provide our best chance for improvement.

Extended threat period with lengthy periods of inactivity followed by brief periods of strong tornadoes – hard to keep guard up that long - desensitizing risk is high.

Evacuation and Sheltering - Evacuate mobile homes in threat area? -This could be 200 miles from landfall and 24 to 36 hours before landfall?

Safe Rooms in homes built for hurricanes will perform well for about 99% of Florida Tornadoes.
Shelters in mobile home parks would be beneficial.

Shelters probably don't exist in most cases. But there are recent success stories:
Gulfstream Harbor Mobile Home Park – Orange Co.
FWIN (Florida Warning & Information Network) Grant
700 Weather Radios for all residents
Community Club House – Engineering Study - Hardened - Impact Screens

Questions?

bart.hagemeyer@noaa.gov